Architecture for Multi-enterprise E-business

by

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Submitted to the System Design and Management Program
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ABSTRACT

Integration and customization are increasingly becoming the dominant trends in the future of electronic commerce (e-commerce). Advances in networking, communications, and distributed computing technologies make it possible to better leverage internal and external competencies. E-business extends the consumer-centric e-commerce realm by including the business-to-business aspect of commerce. This has a much wider impact on traditional ways of doing business as it is fundamentally changing the way companies operate. However, current e-business systems typically do not go beyond business-to-business buy and sell relationships for products and services. The true potential of the Internet for business-to-business commerce offers opportunities to go beyond these buy-sell relationships.

This research analyzes existing e-business models and develops the concept of a multi-enterprise e-business model. Multi-enterprise e-business, an e-broker-based form of virtual enterprises, consists of existing independent businesses that form dynamic on-line (Internet/WWW based) alliances. This enables them to share competencies, information, costs, skills, and resources in order to efficiently meet customer requirements. This research also analyzes the motivation, business models, and technical as well as operational system requirements associated with multi-enterprise e-business. A review of related technologies and models is presented. Based on this analysis, an architecture for a multi-enterprise e-business system is developed. It presents a functional model, system decomposition, and operational analysis of the system.

Two case studies are also presented. One analyzes the state-of-the-art in terms of e-business implementation, and shows how it differs from the multi-enterprise e-business model. The other shows how a successful on-line business model can be further extended using the concepts developed as part of this research effort.

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1 Introduction

1.1 Preview

Integration and customization are increasingly becoming the dominant trends in the future of electronic commerce (e-commerce) [1]. Advances in networking, communications, and distributed computing technologies make it possible to better leverage internal and external competencies. It is becoming easier to forge business-to-business partnerships for delivering products or services customized to customer preferences, as a result of tighter integration between firms.

However, current systems typically do not go beyond business-to-business buy and sell relationships for products and services. For example, a number of online procurement applications provide a set of static catalogs for business customers to order from. This is an example of a typical buy-sell relationship. A more sophisticated example would be a trading system that allows buying and selling of components [2]. Business buyers and sellers can negotiate and trade components, resulting in a typical buy-sell relationship. The true potential of the Internet for business-to-business e-commerce offers opportunities to go beyond these buy-sell relationships. This potential can be realized through a multi-enterprise e-business model.

Multi-enterprise e-business, an e-broker [6] based form of virtual enterprises [3,4,19], consists of existing independent businesses that form dynamic on-line (Internet/WWW based) alliances in order to share competencies, information, costs, skills, and resources in order to efficiently meet customer requirements. They may form temporary or long-term partnerships, with a value chain that cuts across traditional corporate boundaries [4]. The depth of the relationships and the dynamic nature of the partnerships characterize multi-enterprise e-businesses. These relationships go deeper than the traditional buy-sell model, resulting in real-time information exchange and tighter integration between businesses. The ability to form dynamic alliances and value chains provides the ability to customize products and services to a customer's specific needs. This enables real-time decision making, timely capability and capacity assessment, and rapid assembly of products and services.

In this chapter, we will look at some background information related to e-commerce and e-business. We will explore different e-business models that are currently in use. We will identify the objectives and scope of this research effort as we build up to a definition of, and issues related to, multi-enterprise e-business.

1.2 E-commerce and E-business

Traditional commerce is defined as the buying and selling of goods and services. Electronic Commerce refers to the application of electronic media and technologies to traditional commerce activities. In the process, it also opens up new opportunities,

commodities [7], markets, and business models. Application of recent advances in information technology and telecommunications leads to increased efficiency, effectiveness and functionality of traditional commerce practices [6].

Electronic Commerce covers a wide range of commerce related activities including [6]:

- Helping customers in locating appropriate goods and services.
- Making customers aware of new goods and services provided by suppliers.
- Aiding the negotiation process for buying and selling goods.
- Reaching an agreement for conducting a given transaction.
- Managing the delivery of agreed upon goods and services.
- Post-sales service and support.

The term ***e-commerce*** is generally used to refer to the consumer-oriented side of Internet businesses. It focuses primarily on consumer-oriented content and shopping on the Internet. ***E-business*** extends the consumer-centric e-commerce realm by including the business-to-business aspect of commerce. This has a much wider impact on traditional ways of doing business as it is fundamentally changing the way companies operate, by influencing their internal processes and culture [18]. In addition to the consumer side of doing business on the Internet, e-business focuses on lowering the costs of transactions between businesses and throughout their supply chain. We will use this broad definition of e-business as opposed to e-commerce in the context of this research.

1.3 E-business models

A comprehensive study of business models for electronic markets is provided in [14]. Table 1.1 lists the different business models identified in [14] and shows some of their key attributes.

Business Model	Key Attributes
E-shop	• Focus on establishing an additional sales channel • Basic use as a promotion mechanism and for cost-reduction Example: GAP online store [57]
E-procurement	• Electronic tendering and procurement of goods and services • Seek a wider supplier base and reduce costs Example: Wells Fargo purchasing
E-auction	• Framework for electronic bidding • Integration with payment and delivery systems Examples: eBay, Amazon.com [16]
E-mall	• Industry sector marketplace • Focus on aggregation of e-shops Examples: eMall[54]
Third Party Marketplace	• Common marketing front-end managed by third party • Transaction support for multiple businesses Example: TradeZone [15]
Virtual communities	• Focus on value added by data sharing and communication between consumers/partners Example: Amazon.com [16]
Value chain service provider	• Focus on supporting part of the value chain (e.g. logistics management or payment services)

	Examples: UPS, FedEx
Value chain integrator	• Focus on integrating multiple steps of the value chain • Add value by exploiting info. flow between steps Example: MarshallNet [55]
Collaboration platforms	• Provide tools and information for collaboration between enterprises • Support for virtual teams Examples: Global Engineering Network [14]
Information brokers	• Information management and brokerage focus • Brokerage and negotiation support Examples: Yahoo [17], Bloomberg.com [56]

Table 1.1: E-business models

In chapter 2 we will analyze these business models to see how the multi-enterprise model leverages some of their attributes and extends their functionality.

A classification of the business models outlined in Table 1.1 is also provided in [14]. Figure 1.1 shows the classification along two axes: level of functional integration and degree of innovation.

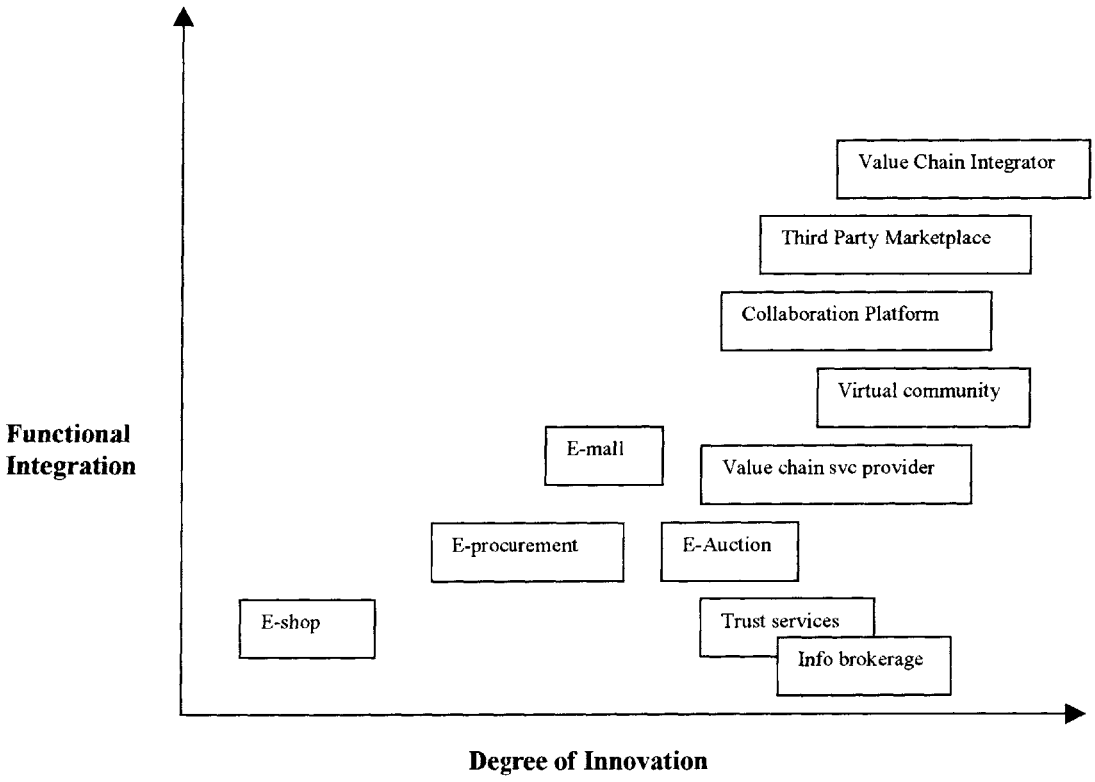


Figure 1.1: Classification of Internet business models [14]

Figure 1.1 shows the evolution of Internet based business models. We will use this classification as a basis for analyzing the multi-enterprise e-business model, in chapter 2.

1.4 Research Objectives

The objective of this research is to define and propose a business model and architecture for multi-enterprise e-business. We will develop a functional model and system architecture for multi-enterprise e-business. We will analyze the motivation, goals, requirements, challenges and models associated with such a system.

The scope and objectives of this research effort include:

- Defining the concept of multi-enterprise e-business
- Comparing and contrasting with existing models for e-business
- Analyzing relevant research and related work
- Determining the system requirements for a multi-enterprise e-business model
- Defining a functional model and architecture for multi-enterprise e-business
- Analyzing case studies that employ multi-enterprise e-business models

Subsequent chapters will address the key areas included in the scope of this research effort.

1.5 Summary

This chapter provided some of the background information related to this research effort. We looked at various business models and identified the objectives and scope of this research. In the next chapter we will focus on the definition of multi-enterprise e-business and see how it evolves from contemporary e-commerce.

2 Multi-enterprise E-business

2.1 Preview

Chapter 1 presented an overview of e-commerce and e-business. We looked at the state-of-the-art in conducting business over the Internet utilizing recent advances in communications and information technology. In this chapter, we will develop a definition for multi-enterprise e-business and identify its attributes and characteristics. We will analyze the motivation for multi-enterprise e-business, define its scope, and identify the challenges that are involved.

2.2 The Concept

Typical e-commerce transactions involve searching for the required goods and services, choosing a supplier, price negotiation, payment, and order fulfillment. The OBI (Open Buying on the Internet) model [10], for example, splits the world into buy-side and sell-side activities for business-to-business e-commerce. Sales are typically catalog-based, as in MRO (maintenance, repair, and operations) procurement applications, frequently with delivery timeframe information. Present day e-commerce architectures focus on the buying and selling process with additional support services like payment processing and delivery. Their objective is to lower transaction costs (buying and selling), and to provide up-to-date information that is easy to access and search. Figure 2.1 shows typical activities and transactions involved in this buy-sell model.

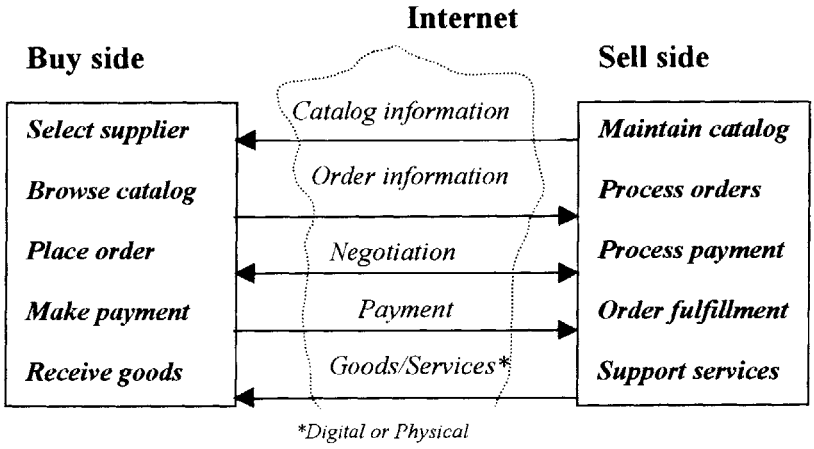


Figure 2.1: Typical buy-sell model

The concept of multi-enterprise e-business blurs the distinction between buy and sell-side operations as a result of seamlessly integrated activities between businesses. This model uses Internet based e-commerce technologies to forge a deeper relationship between businesses. The catalog-based model is replaced by a real-time capacity and capability assessment ability across organizational boundaries. Ordering and order processing are a result of collaborative planning and supply chain integration, resulting in improved visibility across firms. This enables businesses to form dynamic alliances in order to leverage external competencies and economies of scale. It is an extensible framework where primary suppliers can leverage external suppliers, in turn. It also allows operational flexibility so as to provide custom solutions based on customer needs. Figure 2.2 presents a conceptual overview of multi-enterprise e-business.

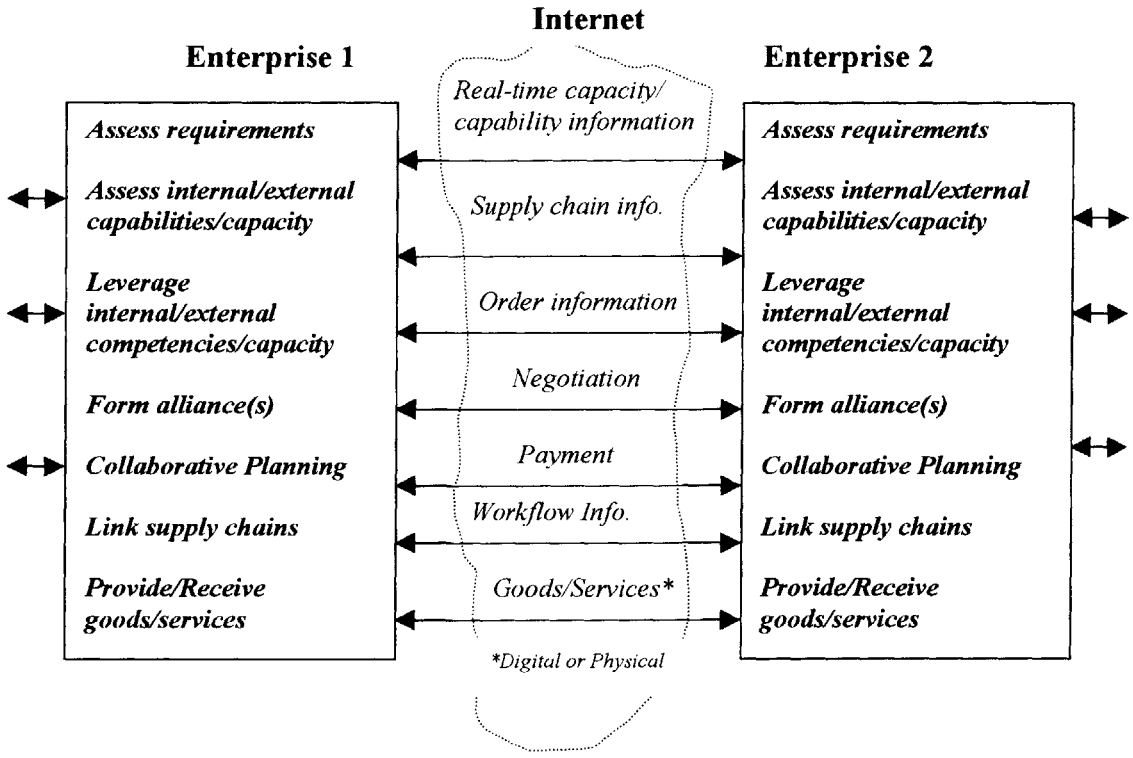


Figure 2.2: Conceptual overview of multi-enterprise e-business

2.3 Key Attributes

In order to develop a definition of multi-enterprise e-business, we will start by identifying some of the key attributes that distinguish it from the contemporary e-business model described in the previous chapter. Multi-enterprise e-business builds upon the existing Internet-based foundation of e-commerce. The focus is on non-proprietary technologies, resulting in an open-ended model allowing for easier integration. One way to contrast

contemporary e-commerce with multi-enterprise e-business, is to think of a spectrum of attributes. At one end of this spectrum is the traditional e-commerce model. At the other end of the continuum is the proposed multi-enterprise e-business model.

Figure 2.3 shows the spectrum of key attributes going from ones that are characteristic of contemporary e-commerce/e-business to ones that define multi-enterprise e-business.

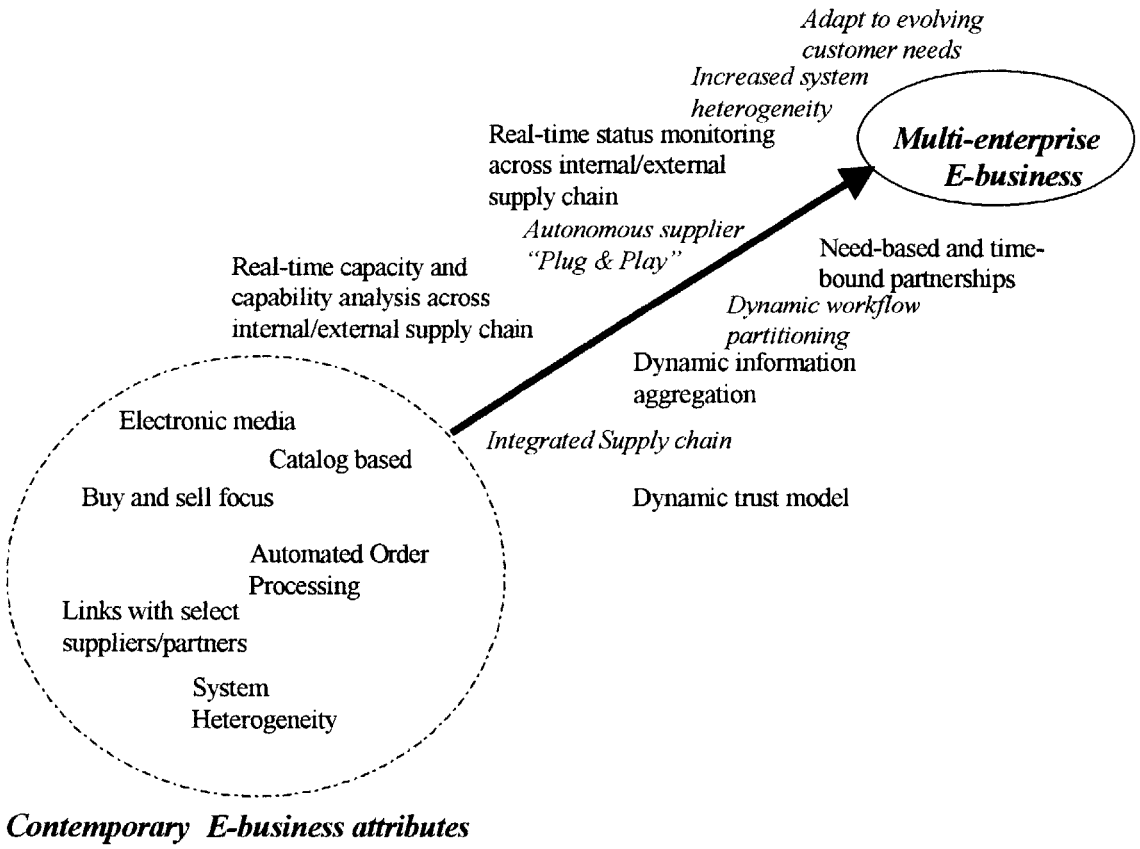


Figure 2.3: Transitioning to multi-enterprise e-business

The transition to a multi-enterprise e-business framework involves moving to a dynamic environment with real-time capabilities. Figure 2.3 shows some of the attributes that lie in the domain of contemporary e-business. It also shows some of the attributes and characteristics that extend this model to that of multi-enterprise e-business. The attributes form Figure 2.3 that enable the transition to multi-enterprise e-business are explained in Table 2.1.

Attribute	Definition
Real-time capability and capacity assessment across internal/external supply chain	The multi-enterprise framework builds upon integrated supply chains found in some e-commerce models. The key here is an ability to perform capability and capacity assessments across distinct business boundaries in real time.
Dynamic information aggregation	As opposed to the catalog-based model, a multi-enterprise framework requires the ability to gather information from diverse (maybe previously unknown) sources in order to provide a consistent interface to the customer(s). This places an increased emphasis on information integration and context mediation.
Autonomous supplier "Plug & Play" – flexible supply chain	In order for a multi-enterprise framework to succeed, it should be easy and convenient to pull in new suppliers into the framework on an as-needed basis. This type of supplier "Plug & Play" demands a great degree of flexibility in the supply chain, to make it easy to interface with new suppliers.
Real-time status monitoring across internal/external supply chain	Real time order status and execution tracking across the individual entities that make up the multi-enterprise framework, is essential in order to provide a unified view to the customer.
Adapt to evolving customer needs	As customer needs change, it is necessary to build new coalitions in order to leverage the required centers of competency. A multi-enterprise framework can dynamically structure its membership to develop custom tailored solutions in the most cost-effective way.
Dynamic workflow partitioning	Evaluating customer requirements, choosing the right suppliers, and allocation work amongst them are some of the most critical steps in multi-enterprise e-business. The ability to dynamically partition and allocate work is crucial in order to ensure proper assimilation of the final product or service.
Need-based time-bound partnerships	Supplier coalitions exist for the duration of the production or service provision process. Suppliers enter the multi-enterprise coalition put together for a particular customer on an as needed basis and leave once their contribution is complete. This is a key dynamic aspect of multi-enterprise e-business.
Dynamic trust model	In a flexible organization like a multi-enterprise framework, the need to share information and status across organizational boundaries increases the need for a secure and trusted environment. As suppliers enter and leave the framework they should be ensured that their intellectual property and critical business information will be protected.

Table 2.1: Attributes enabling the transition to multi-enterprise e-business

2.4 A Definition of Multi-enterprise E-business

Based on our analysis of the key attributes of multi-enterprise e-business, we can now develop a formal definition as follows:

Multi-enterprise e-business is an extension of contemporary Internet-based e-commerce, resulting from tighter integration between autonomous enterprises to enable close-knit, flexible, and dynamic partnerships in order to address changing customer needs in a cost-effective and efficient manner.

One of the key elements of multi-enterprise e-business is the ability of independent businesses to dynamically form on-line (Internet/WWW based) alliances in order to share competencies, information, costs, skills, and resources in order to efficiently meet customer requirements. They may form temporary or long-term partnerships, with a value chain that cuts across traditional corporate boundaries [4]. The depth of the relationships and the dynamic nature of the partnerships characterize multi-enterprise e-businesses. These relationships go deeper than the traditional buy-sell model, resulting in real-time information exchange and tighter integration between businesses. The ability to form dynamic alliances and value chains provides the means to customize products and services to a customer's specific needs. This enables real-time decision making, timely capability and capacity assessment, and rapid assembly of products and services.

Multi-enterprise e-business is a type of e-broker [6] assisted virtual enterprise [3,4,19]. We will analyze other research efforts in this area, in chapter 4.

Based on this definition, we can identify the high-level goals of multi-enterprise e-business as follows:

- Integrate information, components, and services from autonomous entities in order to provide a seamless service or product to the customer.
- Reduce transaction costs and enable suppliers to leverage best-in-class competencies from appropriate (internal or external) sources. In other words, optimize elements of the value chain.
- Enable real-time feasibility, capability and capacity assessment in order to effectively address customer needs.
- Enable new kinds of services/products as a result of integrated activities. This benefits suppliers by giving them the ability to reach a wider market.
- Be responsive to changing customer needs. Supply chain flexibility is one of the most important aspects of multi-enterprise e-business.

These high-level goals translate to a number of requirements and challenges for multi-enterprise e-business, which we will look at in subsequent sections and chapters.

2.5 Motivation

There are a number of motivating factors that lead up to multi-enterprise e-business. We will look at them from a supplier's point of view.

Multi-enterprise e-business is akin to the concept of quasi-integration, which is the establishment of a relationship between vertically related businesses which lies in-between long-term contracts and full–ownership [12]. Quasi-integration achieves many of the benefits of vertical integration without incurring all the costs. Quasi-integration leads to "communities of interest" [12], similar to multi-enterprise partnerships, with specialized facilities that result in lower unit costs, reduced risk of supply and demand interruptions, sharing of information, and reduced risk of capital.

One of the prime motivators is the ability to reduce fixed assets. This can be achieved in a multi-enterprise e-business framework by easily leveraging specialized competencies externally, thus reducing costs and risks [4]. The ability to do this in an automated fashion allows businesses to focus on what they do best. Enhanced real-time communication between partners also leads to better inventory control across the supply chain.

Multi-enterprise e-business also allows suppliers to maximize their investments. This is possible due to the ability to evolve and reconfigure market offerings derived from existing services and components [4]. This agility can be achieved by partnering with different suppliers in order to use the same investments in different scenarios on an as-needed basis. This further leads to an increase in product portfolio and differentiation. Suppliers can gain the ability to provide a diverse portfolio of products and services via bundling of components from various suppliers. Ultimately, suppliers can compete in a broader market and increase market scope, by utilizing internal and external competencies and products, compared to those of a single firm.

A multi-enterprise framework also enables suppliers to reduce time-to-money by efficiently and economically sourcing from other suppliers in order to meet customer requirements in a timely fashion. This lowers the search and contracting costs in dealing with other suppliers and buyers [11], by using Internet based communications technologies.

Overall, businesses can increase customer convenience by providing one-stop-shopping for customers through seamless integration at the supplier level. Thus, a multi-enterprise framework benefits both the customers and the suppliers, which is one of the primary motivating factors. Suppliers can increase their efficiency and at the same time provide a more custom-tailored shopping environment for customers.

2.6 The Business Model

We looked at a framework [14] for analyzing different business models in e-commerce, in the previous chapter. The concept of multi-enterprise e-business extends this framework to include a higher level of integration and innovation.

The need for tighter links between autonomous entities raises the level of functional integration. A multi-enterprise e-business model requires dynamic real-time supply-chain links that go beyond simply exchanging buy-sell transaction and customer information. It is more than information aggregation by a third party, or sharing of transaction and customer information. The ability to perform real-time capacity and capability analysis in a dynamic environment across autonomous entities requires more than just static value chain integration. This is why our multi-enterprise e-business model is higher on the functional integration scale than the third party marketplace or value chain integrator models. It is also a direct consequence of the requirement to provide a seamless front to customers through workflow management.

The dynamic and time-bound nature of coalition formation requires a higher degree of innovation beyond just offering links to external functionality. Our model builds upon innovative elements of other models and adds to the attributes outlined previously. Management of the dynamic environment necessitates a higher degree of innovation that places our model beyond the value chain integrator model.

Table 2.2 shows the key attributes of some of the business models outlined in [14] and explains how our multi-enterprise e-business model leverages these attributes and builds upon them.

Business Model	Key Attributes	Features leveraged/extended for multi-enterprise e-business
Third Party Marketplace	Common marketing front-end managed by third party. Transaction support for multiple businesses.	Leverage features that form the basis for providing a seamless front to customers. Leverage element of neutrality: Neutrality of third party leads to more confidence among suppliers and customers.
Virtual communities	Focus on value added by data sharing and communication between consumers/partners.	Leverage performance-tracking features: Experience-sharing between businesses leads to track records useful for capability evaluation. Also useful for evaluating past performance of different enterprises.
Value chain service provider	Focus on supporting part of the value chain (e.g. logistics management or payment services).	Model needs to be extended to cover services across the entire value chain in a dynamic environment.

Value chain integrator	Focus on integrating multiple steps of the value chain. Add value by exploiting info. flow between steps.	Extend model to integrate the entire value chain for seamless information flow. Extend model to accommodate need for real-time capability and capacity analysis across different trading partners in a dynamic environment.
Collaboration platforms	Provide tools and information for collaboration between enterprises. Provide support for virtual teams.	Extend to support capacity evaluation phase. Extend model to support supplier "plug & play".
Information brokers	Information management and brokerage focus. Brokerage and negotiation support.	Extend model to allow coordination and support services in a dynamic multi-enterprise environment. Handle information flow, contract management etc. between businesses and with customers.

Table 2.2: Extending traditional business models for multi-enterprise e-business

Figure 2.4 shows an extension of the framework proposed by [14], in order to capture the multi-enterprise e-business model. As shown in Table 2.2, the multi-enterprise e-business model builds upon key attributes of existing models, in particular the value chain integrator, third party marketplace, and collaboration platform models. It extends the attributes of these models along the functional integration and innovation dimensions.

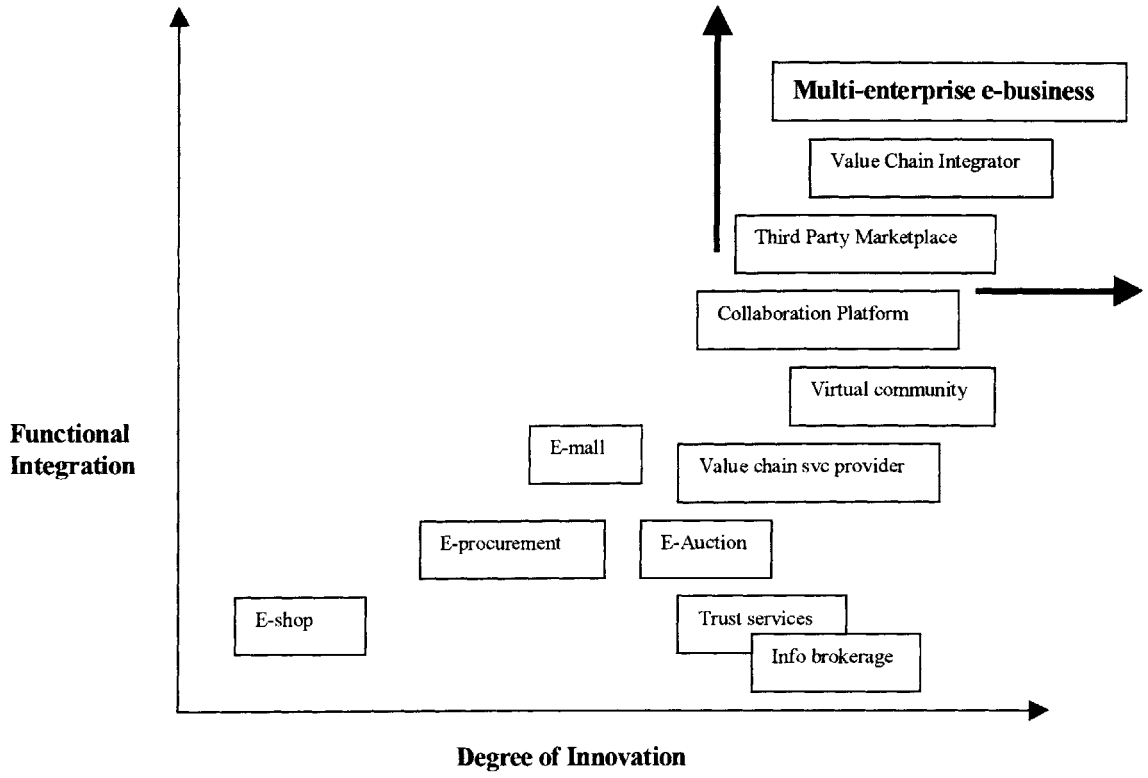


Figure 2.4: Multi-enterprise e-business in the electronic business model framework

2.7 Stakeholders

As contemporary e-commerce evolves into multi-enterprise e-business, it needs to serve the distinct needs of various stakeholders. The primary stakeholders in a multi-enterprise e-business are the customers, suppliers, coordinators or brokerages, support organizations, and standards setting bodies.

Customers of the end product or service are the primary stakeholders. The activities of a multi-enterprise e-business should be driven to address specific needs of customers. It is important to present a seamless front to the customer given that there are multiple autonomous entities involved in a multi-enterprise framework.

Businesses and suppliers involved in the multi-enterprise alliance form another set of stakeholders with the primary intent of increasing the efficiency of their operations. Different levels of suppliers result in internal customer-supplier relationships. In order to enable multiple independent business to operate together in an automated fashion, there is a need for a high degree of coordination between their activities.

Coordinators or electronic brokerage are responsible for a number of activities in order to make multi-enterprise e-business a viable business model. As stakeholders, they expect

the cooperation of all suppliers and an agreement on business and operational rules. They are responsible for delivery to customer in the multi-enterprise scenario.

Support organizations include entities responsible for the installation, administration, and maintenance of the required hardware and software infrastructure. They also include entities responsible for providing post-delivery service and support. As stakeholders, they rely on suppliers and customers for providing required hardware and software information in order to ensure interoperability. They also rely on information from suppliers in order to provide after-sales support to the customer.

Standards organizations like RosettaNet [13] are involved in setting industry-wide electronic business interoperability standards. From a stakeholder point of view, such organizations would like to ensure that businesses adhere to their set of standards in order to speed its adoption.

The needs and requirements of various stakeholders lead us to a set of challenges for multi-enterprise e-business, which we will investigate in the next section.

2.8 Challenges

The multi-enterprise e-business concept faces a number of business and technical challenges. This section investigates some of the key challenges.

The very nature of multi-enterprise systems implies a highly diverse hardware and software base. This leads to a heterogeneous set of information sources which makes it challenging to maintain information consistency and understand the context of different sources. Correctly interpreting information from different sources in a dynamic environment is a challenging task.

The complexity involved in automatically coordinating the activities of a multi-enterprise framework presents a significant challenge. As the value chain cuts across autonomous entities in a dynamic environment, it leads to complex organizational models.

It is necessary to protect the assets of member companies of the multi-enterprise framework. Protection of intellectual property and private information is important for this model to succeed. However, this presents us with a significant challenge due to the dynamic nature of the need-based partnerships, which characterize multi-enterprise e-business. Privacy could be an issue for customers as well as suppliers. The need for a system wide trust model is critical in this environment.

Providing a seamless front to customers is another significant challenge due to the number of entities involved. It should be convenient for a customer to do business in this framework. It is necessary to address the issue of comparative efficiency, where it should be easier for a customer to do business within the multi-enterprise framework rather than with each individual supplier.

Providing after-sales customer support presents an interesting challenge for multi-enterprise e-business systems. Due to the need-based coalitions of suppliers, the entity that provided the product or service does not exist after the product or service is delivered. The challenge is to structure contractual obligations such that customers receive after-sales service and support when they need it.

Technical issues related to designing the architecture for such a system pose another significant challenge. The architecture should support a dynamic "plug & play" environment for suppliers, and enable real-time collaboration across the flexible supply chain.

2.9 Summary

In this chapter, we have introduced the concept of multi-enterprise e-business and shown its evolution from contemporary e-commerce systems. We have provided a formal definition of multi-enterprise e-business and identified specific stakeholders and challenges. We have seen how the new model builds upon existing models in e-business by extending the level of functional integration and the degree of innovation. In the next chapter, we will look at related research and commercial activity.

3 Related Work

3.1 Preview

In this chapter we will analyze a number of research activities in areas similar to multi-enterprise e-business. Our concept of multi-enterprise e-business is derived from the notion of virtual enterprises and builds upon some of this research and related commercial implementations outlined here.

3.2 Electronic Brokerage Systems

Given the increasing number of providers of goods and services over the Internet, it is a challenge for customers to select and buy the right services or goods at an acceptable price. An on-line electronic brokerage (e-broker) presents an appealing solution to address the increased uncertainty and fluidity in e-commerce [6,7]. A broker mediates between suppliers and consumers, addressing a wide variety of issues including location, selection, pricing, trust, and heterogeneity. It also servers as an equalizer by allowing small suppliers to compete effectively with large suppliers.

[6] describes a functional architecture for an e-brokerage system to help in locating and purchasing online information, goods, or services. It's model is defined in terms of roles, actions, events, and entities that makeup an electronic brokerage system. The functional architecture describes functional elements that embody these entities. A brokerage in this model may interact with customers, suppliers, or other brokerages in the supply chain.

The need for a brokerage system in e-commerce scenarios is outlined in [5]. It also presents a brokerage model for providing search, negotiation and trusted services. [9] presents a model for brokerage services in a distributed electronic commerce environment. [30] looks at issues related to the need for providing brokering services in the case of multiple suppliers in order to match customer constraints in the context of a distributed print-on-demand scenario. [31] discusses an electronic brokerage based procurement system for business-to-business commerce.

Brokers or trusted intermediaries help in creating an environment of trust between participants in e-business transactions [34]. They may also be used to facilitate information sharing between mutually distrustful parties, and enable previously infeasible transactions. The notion of a trusted intermediary is also presented in [35], which describes metrics and models for measurement of trust variables in electronic commerce.

In reviewing the available literature, it becomes evident that the concept of electronic brokerages needs to be extended to address a dynamic environment of supplier "plug and play" that is required for multi-enterprise e-business. It should also allow for tighter integration and deeper links between suppliers to satisfy the requirements of multi-enterprise e-business, along with increased monitoring of activities. An extended model

of an electronic brokerage would provide the means to leverage the current e-commerce infrastructure and create an environment for multi-enterprise e-business.

3.3 Virtual Enterprises

The concept of a virtual enterprise is similar to that of multi-enterprise e-business. The multi-enterprise e-business model is a type of virtual enterprise that leverages the concept of an electronic brokerage to provide support services.

Virtual enterprises (VEs) are defined as the formation of temporary alliances by existing businesses in order to share their cost, skills, and resources for supporting specific objectives [3,4,20]. An example of a VE in the context of the travel industry would be the collaboration between travel agents, airlines, ground transportation services, entertainment services and so on [3]. Research in virtual enterprises has addressed a number of issues including the formation of a VE and efficient sharing of information [3, 19]. Workflow management systems [3,24,25] are being proposed as a solution to the problem of coordinating activities across multiple entities. [26,27,28] discuss the use of workflow management techniques for electronic commerce in general. The use of mobile software agents has been proposed as a means to establishing virtual enterprises and managing information transfer within them [3].

Management of heterogeneous data sources in virtual enterprises is another research area that has been studied, particularly in the context of delivering digital goods. IMP, Internet Marketplace, described in [19] addresses the problem of integrating information from diverse sources and deriving data based on customer requests. Distributed information management in virtual enterprises is analyzed in [21]. [23] looks at information security issues facing virtual enterprises.

[3] proposes a framework for analyzing virtual enterprise infrastructure. The key dimensions for analysis include the number of participants, number and type of boundaries, business volume, economic value, transaction turnaround time, trust model, and level of bonding between business partners. [20] and [22] propose a formal framework for modeling and analyzing interactions in a virtual enterprise.

The goals of a virtual enterprise are similar to those of a multi-enterprise e-business. However, there has been little work done in addressing the support services required for virtual enterprises [29]. Some research has focused on decentralized models of virtual enterprises, like [3] based on agent technology. Our multi-enterprise e-business model marries the concept of an electronic brokerage with that of virtual enterprises. By doing so, we provide a broker-assisted model of a virtual enterprise. It is an evolution of current e-commerce models and enables a convenient migration path to multi-enterprise e-business. An electronic brokerage can be used to provide an unbiased and secure environment for multi-enterprise e-business.

3.4 Virtual Integration and Lean Production

Virtual integration is a tight partnership between business partners such that suppliers are treated as if they are part of the company [31, 32]. It borrows from concepts related to a Just-In-Time (JIT) delivery relationship with customers in order to substitute information in place of inventory throughout the supply chain. Dell Computer Corporation pioneered this model in the build-to-order PC business. Lean production [33] and related supply chain management efforts also lead to similar tight integration with first-tier suppliers, characterized with a high degree of communication.

The virtual integration model is based on a consortium of suppliers with whom a company has pre-established operating procedures. These suppliers have instant access to demand information and are thus able to supply components in a timely fashion. Virtual integration can be considered to be a static form of multi-enterprise e-business. It has the integrated supply chain and collaborative planning characteristics of multi-enterprise e-business. However, the notion of a true multi-enterprise e-business goes beyond the virtual integration model by introducing a dynamic supplier base with which a company might not have pre-established relationships. Suppliers may participate on an opportunistic basis depending on their current capacity and capability. It can be argued, though, that a dynamic multi-enterprise e-business scenario might not be appropriate for all kinds of situations in which a virtual integration model is applicable. Some situations like auto production, especially for newer models, require pre-established links with first-tier suppliers, right from the outset [33]. These situations exhibit most characteristics of multi-enterprise e-business except the concept of a dynamic supplier base for first tier suppliers.

3.5 Information Heterogeneity

Integrating information from diverse and dynamic sources presents a major problem for supplier interoperability in multi-enterprise e-business scenarios.

The notion of virtual database (VDB) technology is introduced in [36], where external data from other sources is viewed as an extension of an enterprise's relational database system. VDB enables queries across multiple scattered data sources. It employs wrappers to access data, and mappers to translate and convert data based on mapping rules.

The problems and challenges associated with semantic integration of diverse and distributed information sources are discussed in [37, 38]. The need for "logical connectivity" in addition to "physical connectivity", is highlighted so that information from diverse sources can be meaningfully integrated. Also, the problems with large scale semantic heterogeneity are outlined, where sources and receivers of data might have different implicit assumptions about context definition(data meaning) and context characteristics (data quality).A context interchange architecture is introduced, which provides context mediation services between data sources and receivers. It consists of wrappers, mediation services, middleware, interface and facilitation services. It uses metadata to represent context definitions, which are used to compare contexts across

different sources and perform context conversions if necessary. A practical implementation of context mediation services is provided in [39].

The context interchange architecture is appropriate for addressing the interoperability problems in a dynamic supplier base within a multi-enterprise e-business model. Context mediation services can be encapsulated within an e-broker that facilitates information exchange in a multi-enterprise e-business model.

[45] gives a good overview of object-based middleware to address the problems of information systems interoperability. It includes a discussion on CORBA, DCOM and information brokering.

3.6 Agile Manufacturing

Agile manufacturing [40, 41], is a new manufacturing paradigm characterized by increased flexibility and responsiveness. It is defined in [42] as "A manufacturing system with extraordinary capability to meet the rapidly changing needs of the market place. A system that can shift quickly amongst product models or between product lines, ideally in real-time response to customer demands.".

Principles of agile manufacturing include [40] constant evolution, knowledge based assets, virtual partnerships in the form of dynamic organizational structure, and a value based approach to customer solutions. Agile manufacturing enables mutually beneficial collaboration between competitive entities in order to meet customer needs. It borrows and integrates concepts from computer-integrated engineering, flexible manufacturing systems, knowledge based engineering, and lean production.

The National Industrial Information Infrastructure Protocols (NIIIP) consortium is developing the infrastructure to enable integration and interoperation among Manufacturing Execution Systems (MES) and Enterprise Information Systems within and across companies [43]. This allows information sharing across diverse domains and enables coalitions of different enterprises. This in turn promotes agile manufacturing through standard communication frameworks and inter-enterprise information control and security [43].

Agile manufacturing is similar to the formation of virtual enterprises in the manufacturing world in order to meet customer needs. The principles of agile manufacturing are directly applicable to the multi-enterprise e-business model.

3.7 Supply Chain Integration

Supply chain integration is also known as "demand chain integration" or "order cycle management" [52]. It includes all the coordination and integration activities related to planning, scheduling, logistics, and production, among other things. Integrating the supply chain using information technology provides a significant competitive advantage

[52]. It also enables concurrent engineering by enabling data sharing with partners throughout the entire life cycle of a product [53].

Supply chain integration is essential to the success of a multi-enterprise e-business model. It relies heavily on integrating supply chains of partners in a dynamic environment, in order to enable data sharing across the immediate boundary of a supplier. The multi-enterprise e-business model extends the static supply integration model to a dynamic one in order to enable supplier plug-and-play.

3.8 Agent-mediated Systems

Software agents are personalized, continuously running, semi-autonomous programs to which tasks can be delegated [44]. These agents can automate a number of tasks in the buying and selling of goods and services over the Internet. [44] uses the Customer Buying Behavior (CBB) model to explore the role of agents as mediators in electronic commerce, and to categorize existing systems. The stages are - need identification (becoming aware of a need), product brokering (determining what to buy), merchant brokering (determining who to buy from), negotiation (determining terms of the transaction), purchase, delivery, service, and evaluation (of customer satisfaction).

In looking at the future of agent-mediated systems, [44] forecasts that future agent-mediated systems will form dynamic partnerships between previously unknown parties-creating coalitions in order to satisfy customer needs and leverage economies of scale. This is similar to the concept of virtual enterprise and multi-enterprise e-business models.

3.9 Summary

We have reviewed a number of related research efforts in this chapter. We have also seen how they each relate to the concept of multi-enterprise e-business. In summary, the multi-enterprise e-business model builds upon a number of features of the other models and research efforts presented here.

4 Requirements

4.1 Preview

In this chapter we start with a problem definition that illustrates the need for e-broker assisted multi-enterprise systems. We will then explore the state of the art in electronic brokerage systems and identify system requirements for an e-broker assisted multi-enterprise e-business model. These requirements will then be used to develop the architecture of the system, in the next chapter.

4.2 Problem Definition

In an increasingly customer-centric world, the Internet has helped transform the business relationship from a supplier-centered one to a customer-centered one [8]. There is an increasing focus on customer needs, convenience and requirements. On the other hand, businesses are exploring new models in order to increase efficiency, profitability and market competitiveness.

E-commerce has broadened to include electronic brokerage assisted business models in order to serve customers better. E-brokers help customers in locating products or services, negotiating for them, and ordering them. They also include a number of additional services to ease the customer's shopping experience. E-brokers help businesses by providing them with a wider market and an interface to the customer. However, current models of e-broker assisted e-commerce systems do not go beyond aggregation, order management, catalog management and payment services from a supplier point of view. In short, the true potential of e-brokers is not being exploited for increasing business efficiency, profitability and competitiveness from a supplier point of view.

Electronic brokerages need to expand their business model to include services to address suppliers' needs for increasing efficiency. E-brokers should provide a framework to leverage supplier specific key competencies, and should support contract management in order to breakdown customer requirements and assign pieces to suppliers with appropriate competencies. Work allocation should also be performed based on a real-time assessment of capacity, capability, and economies of scale. This implies a deeper relationship between e-brokers and suppliers as well as between various suppliers themselves. It also requires dynamic supply chain management and cooperation between suppliers with diverse systems and business practices.

By forming and supporting dynamic coalitions of suppliers to address customer requirements, e-brokers can simultaneously address the needs of customers and suppliers. Customers can expect custom-tailored solutions to address their specific requirements in

a cost-effective way. Suppliers can increase their effectiveness by focusing on their key strengths and gaining access to a wider market.

These new requirements on e-brokers and suppliers lead to a number of problems that need to be addressed. Current research on broker assisted e-commerce systems [5,6,9] does not go beyond the typical buy-sell scenario and is often limited to information or digital goods. The key problem here is to expand the role of electronic brokerages to handle the requirements of multi-enterprise e-commerce and to extend the horizon beyond information goods into other industries.

The next section outlines the e-commerce value chain and how the value-added services increase in going from a generic model to an e-broker assisted multi-enterprise e-business model.

4.3 Impact on the Electronic Commerce Value Chain

4.3.1 Generic E-commerce Value Chain

The process of beginning with raw material and creating an item or service to be provided to a customer includes a number of steps. At each step of the process, addition of value leads to the next step in the process. This is referred to as the "value chain" for a product or service. A generic commerce value chain drawn from [8] is shown in Figure 4.1.

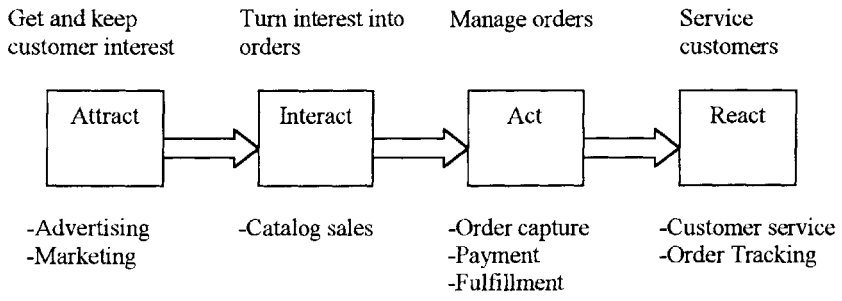


Figure 4.1: Generic e-commerce value chain

4.3.2 E-Broker Assisted E-commerce Value Chain

Extending the generic value chain to include an electronic broker results in a new value chain shown in Figure 4.2. New functionality is shown in italicized font. An e-broker

assisted e-commerce value chain includes additional value added features like location services (to locate goods or services based on customer criteria), supplier information aggregation, negotiation support, ability to address heterogeneous information sources, order process automation and order consolidation. Broker assisted systems can range from the simple case of a major supplier aggregating information from complementary sources to the sophisticated case of brokers providing product location services based on customer requirements and interfacing with appropriate suppliers.

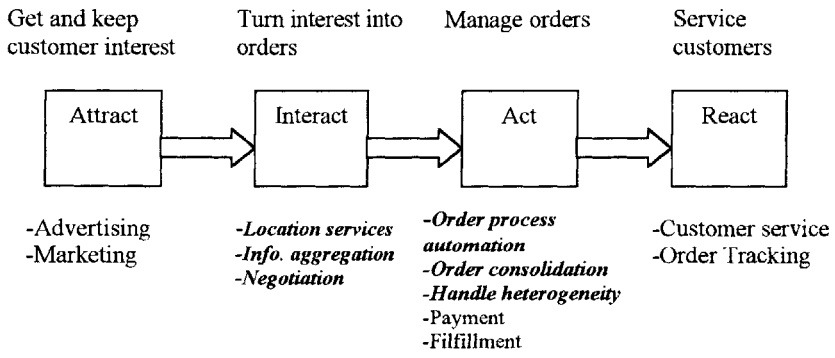


Figure 4.2: E-broker assisted e-commerce value chain

4.3.3 E-broker assisted Multi-enterprise E-business Value Chain

The requirements of multi-enterprise e-business demand a number of value added services from an e-broker. The flexibility, dynamic nature and heterogeneity of a diverse supply base create the need for additional functionality. Among these new value added services are- contract management, capacity assessment, dynamic supply chain management and visibility, context mediation in a dynamic environment, and temporary/long-term alliance management. This value chain is illustrated in Figure 4.3. New services are shown in italicized font.

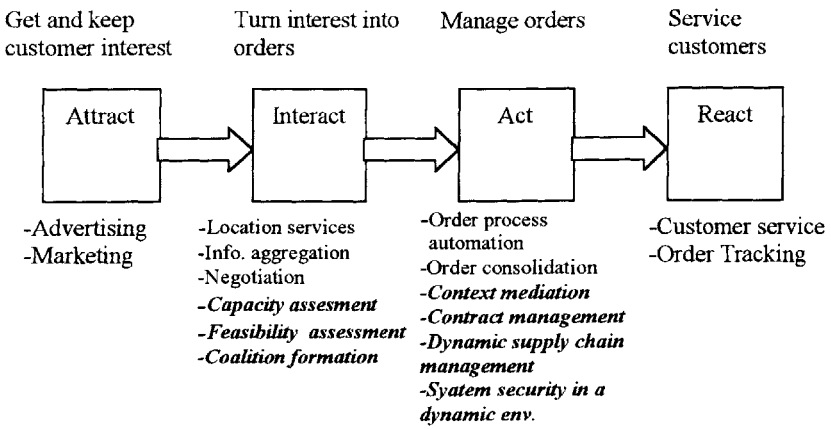


Figure 4.3: E-broker assisted multi-enterprise e-business value chain

4.4 Electronic Brokerage Today: A Classification

Given the increasing number of providers of goods and services over the Internet, it is a challenge for customers to select and buy the right service or goods at an acceptable price. An on-line electronic brokerage (e-broker) presents an appealing solution to address the increased uncertainty and fluidity in e-commerce [6,7]. A broker mediates between the suppliers and consumers, addressing a wide range of issues including location, selection, pricing, trust and heterogeneity. It also acts as an equalizer by allowing small suppliers to effectively compete with large suppliers.

Based on a study of commercial electronic brokerage systems in e-commerce today, we have developed a classification to categorize these systems. It may be used to differentiate the type and level of service offered by existing brokerages. The classification is shown in Table 4.1.

Brokerage Model	Characteristic(s)	Example
Singular supplier	Normally run by large distributors.	Spotmarket.com by Marshall Industries
Closed model	Limited number of suppliers. Normally led by a primary supplier that acts as the infomediary.	Orderzone.com by W.W. Grainger
Open ended model	Open to new suppliers to register and sell.	Intelliquest.
MRO suppliers	Maintenance, repair (replenishment) and operating supplies vendors.	Orderzone.com

Operating resources suppliers	MRO+ capital equipment+ travel+ entertainment services etc.	Ariba
Information goods	Online software, music, soft goods distribution.	Ratexchange Inc. for bandwidth allocation
Static Catalog	Provides static catalog to search and order from.	Sciquest.com
Open Exchange	List what is available at that moment (dynamic).	Spotmarket.com, Chem Connect
Private exchange	Open-ended model; allows private communities.	i2
Public exchange	Part of the open-ended model.	Intelliquest
Vertical focus	Sub-marketplaces for vertical industries like aerospace, electronics etc.	VerticalNet.

Table 4.1: A classification of electronic brokerages today

These models range from singular suppliers, essentially large distributors, to brokerages that focus on catering to all aspects of a particular industry (vertical focus). These brokerage have not evolved beyond the basic catalog type model with a static supply base. The following section captures the key features of these brokerage models to provide a unified view of current brokerage systems.

4.5 Electronic Brokerage Today: A Model

Electronic brokerages today are mostly found in procurement applications ranging from MRO supplies to vertical industry raw materials. Based on a study of existing electronic brokerage systems shown in Table 4.1, the model shown in Figure 4.4 was developed. This business model provides a comprehensive overview of different modes of operation and support services provided by e-brokers today.

The key characteristics of this model are:

- Catalog based systems with products in supplier inventory. Products are usually not customized for different users. This results in an efficient supply source for a limited number of products.
- A static supply chain, with a limited number of suppliers whose catalogs are available to the broker. On occasion, external suppliers may be brought in to provide new services or products. But the static nature of the products pre-determines the supply chain framework.
- The e-broker provides a number of value added services as shown in the figure.
- Brokerages can extend this model by linking to other brokerages in order to leverage external suppliers.

Due to the static links between the e-broker and the suppliers as well as between the suppliers themselves, the e-broker can provide accurate and real-time product tracking information to the buyer. In other words, visibility throughout the supply chain is high.

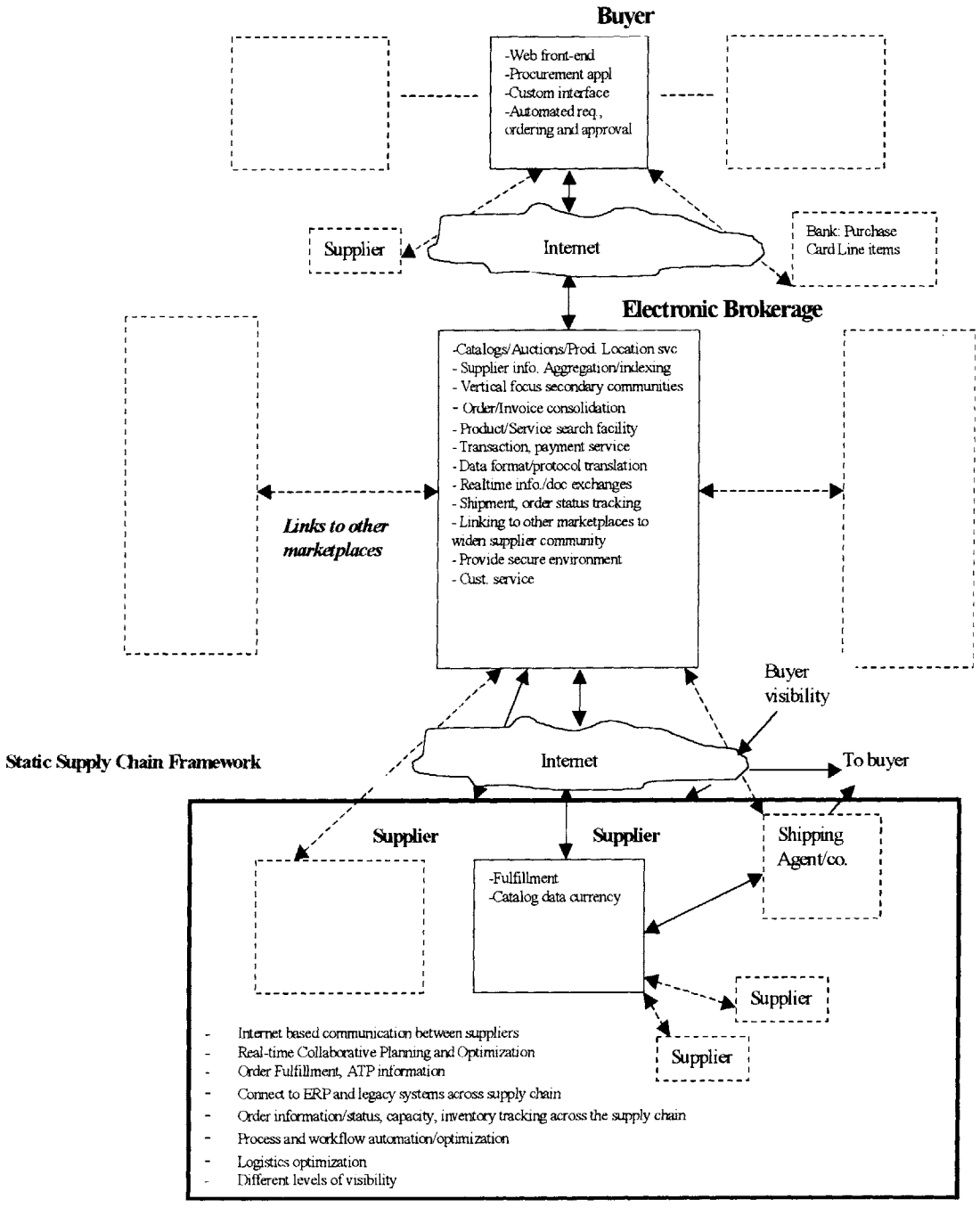


Figure 4.4: A model of electronic brokerages today

4.6 Extending the Model for Multi-Enterprise E-business

The state-of-the-art in electronic brokerages can be extended to support the unique needs of multi-enterprise e-business. The primary extensions to the model are as follows:

- ***Enable dynamic and temporary*** coalition/alliance formation to support customer needs. The broker should have the ability to dynamically configure an alliance of autonomous enterprises in order meet custom requirements. It should be able to manage all the contractual arrangements as part of this coalition.
- ***Enable customer request breakdown*** and ***dynamic workflow partitioning.*** The e-broker is responsible for work breakdown, work assignment, final aggregation and delivery mechanisms between suppliers and to the customer.
- ***Support an extensible framework*** in order to leverage appropriate centers of competency. Allow new suppliers to join and leave the system easily. Enable the creation of global cross-market supply chains and enable "supplier plug & play".
- ***Enforce dynamic system security models*** in an ever-changing environment with suppliers being part of one of more coalitions simultaneously.
- ***Increased context mediation*** for data integration from different sources in a dynamic environment. As new suppliers enter and leave the framework, supply chain information needs to be collected and made available to the customer for real-time tracking purposes. This is also essential in order to perform real-time capacity and capability analysis.
- ***Provide a one-stop shop solution.*** Provide a seamless front to customer and enable new forms of products and services through aggregation of capabilities of different suppliers.

These extensions to the existing brokerage model lead to a new model in which the supply chain is dynamic, and often a temporary one. The new model is shown Figure 4.5. It should be noted that there is a recursive nature to this model in the sense that suppliers to this model could actually be other e-brokers providing a seamless service to the primary e-broker and so on. Also, e-brokers can negotiate with other e-brokers in order to borrow suppliers with specific competencies to build coalitions. In addition to this, independent suppliers can be leveraged by the system at any time.

There are different ways in which supplier coalitions can be formed (a coalition might employ one or more of the following modes of inter-supplier communication):

- Suppliers interacting with each other directly through known interfaces. In this case suppliers normally have pre-existing relationships.
- Suppliers interacting with each other through the e-broker.
- Suppliers attached to different e-brokers being borrowed across e-brokers.
- Independent suppliers not attached to a broker (broker might not know of their existence) working with other suppliers on a contract basis.
- A supplier might be an e-broker external to the system (recursive relationship).

Figure 4.5 shows a model for e-broker assisted multi-enterprise e-business.

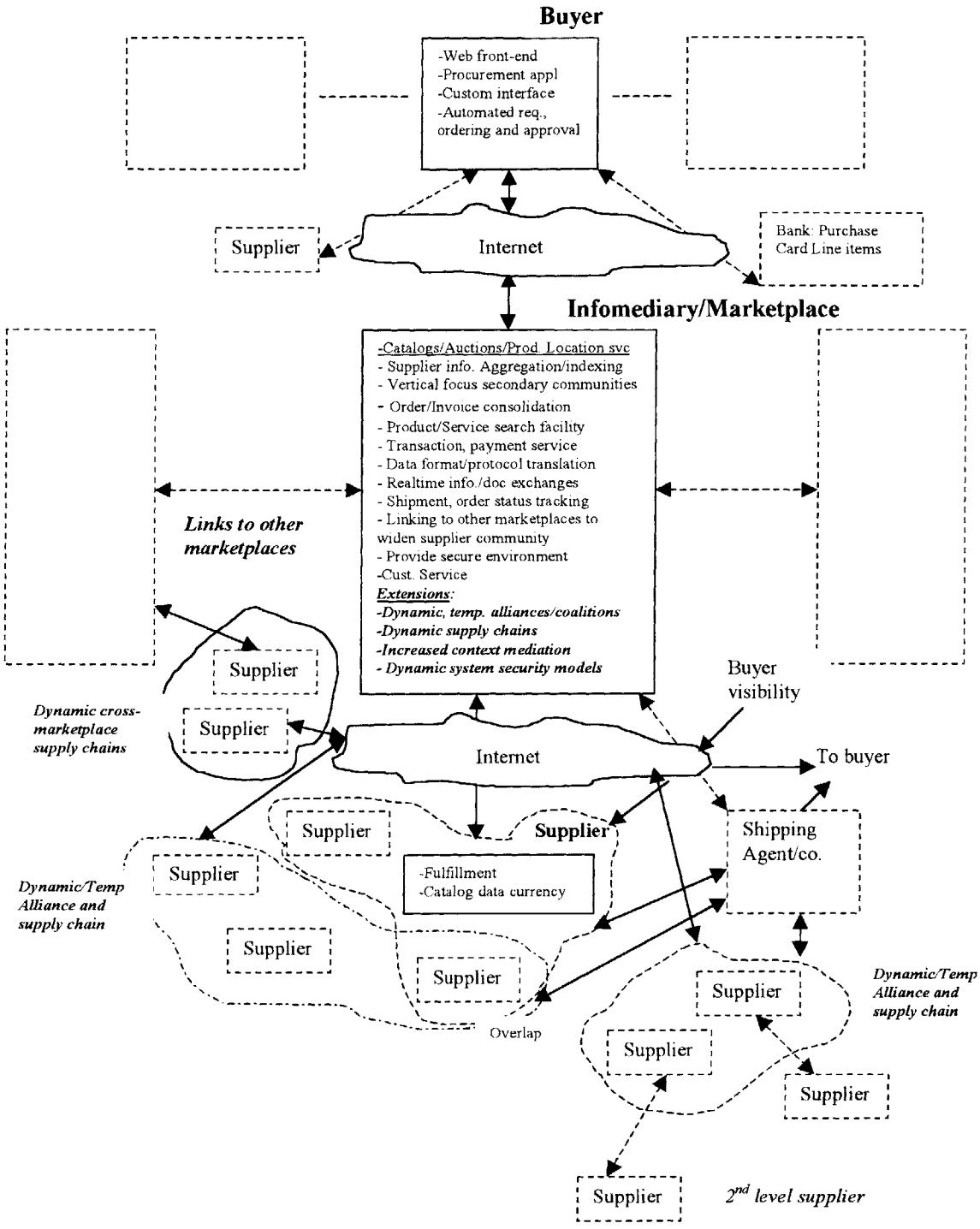


Figure 4.5: An e-brokerage model for multi-enterprise e-business

Due to the number of ways in which coalitions can be formed, there is a critical need for coordinating the activities of multi-enterprise e-business frameworks. This responsibility is handled by the e-broker. Heterogeneous systems and different business practices also add to the coordination overhead.

4.7 Customers and Needs

A broker assisted business model involves two sets of customers- suppliers and consumers of the goods and services. Each set of customers has its own set of distinct needs and requirements. In the context of a multi-enterprise e-business, we will classify customers as internal and external customers. The needs of each type are described below.

4.7.1 External Customers

External customers are consumers of the products or services provided by the multi-enterprise e-business.

The primary needs of external customers include the following:

- Convenient search, selection, and ordering mechanism
- One-stop-shop and "single point" negotiation (dealing with a single entity rather than multiple businesses)
- Customized solutions to their problems.
- Privacy/Security (for sensitive data etc.) and anonymity (if required)
- Timely delivery of product/service as per agreement
- Post delivery support and service mechanism

4.7.2 Internal Customers

Internal customers are suppliers that participate in the multi-enterprise e-business model.

The primary needs of internal customers (suppliers) include the following:

- Protection of intellectual property and assets; privacy and anonymity (if desired)
- Timely and accurate payment for products delivered or services rendered
- Ability to conveniently contract out services/components to other businesses within the framework
- Ability to quickly assess capabilities and resources of other businesses in the multi-enterprise framework in order to respond to customer queries about products/services that require integration across multiple businesses

The needs of internal and external customers drive the system level requirements for a multi-enterprise e-business model, as outlined in the next section.

4.8 System Requirements

We will analyze system requirements on two levels. First, we will look at the requirements of traditional e-commerce systems and how they extend into the multi-enterprise e-business domain. Then we will look at new system requirements that arise out of customer needs, which need to be satisfied by multi-enterprise e-business systems.

4.8.1 Extensions to Traditional E-Commerce System Requirements

Most of the system requirements for multi-enterprise e-business evolve out of existing system requirements for traditional e-commerce systems. Table 4.2 illustrates how requirements for multi-enterprise e-business are extensions of the requirements for traditional e-commerce.

System Requirement	Role in traditional e-commerce	Extension(s) for multi-enterprise e-business
Security and certification	Privacy, authentication, and non-repudiation.	Extensions to control information that is shared between businesses that make up the enterprise (intellectual property and security concerns). The challenge is to establish a trust model that handles this effectively, without hampering cooperation.
Auditing Support	Ensure that contracts are executed as specified in the terms and conditions. Also review fairness and compliance with legal requirements.	Additional requirements to track businesses involved in a given transaction. Need to ensure compliance across businesses.
Negotiation framework	Need to automate and standardize on-line negotiation process (protocols, methods).	Multi-party negotiation support based on agreements between different businesses that form the multi-enterprise.
Payment systems	Systems to ensure secure payment channels.	Systems to track and coordinate payment systems across different businesses and allocate payments to different businesses in the multi-enterprise.
Human Resources Integration	Ability to integrate human resources in order to leverage human expertise.	Similar.
Service brokers	Brokers are helpful in cases where decentralization of functions exists (transportation and logistics).	Extended role of brokers in order to coordinate a slew of activities between businesses and possibly provide a front to the customer. Brokers can play a critical role by providing the means for integration between businesses.
Catalog based functionality	In order to provide a complete and up-to-date list of available	Additional requirement that any catalog should reflect real-time

	services/products, a catalog based model is employed.	changes in resources/services/ products/ components within any of the businesses of the multi-enterprise. Information has to be gathered from multiple sources and kept up-to-date. In a number of cases, catalogs might not exist, and capacity/capability analysis might have to be done on a real-time basis depending on specific customer requirements.
Interoperability	With different computer systems and information sources, interoperability is essential for a global network.	Increased need for interoperability across multiple, heterogeneous sources due to the number of businesses involved.
Logs and Documentation	Need to maintain a record of transactions and performance	As transactions are distributed across a number of independent businesses (to satisfy a single customer requirement), there is a need to closely track progress and performance of the distributed businesses.
Performance and reliability	System should meet/exceed customer expectations of performance and reliability.	Increased number of players highlights the need for the system as a whole to perform up to customer expectations.
On-line and physical delivery distribution	Delivery mechanism needed for digital goods. On-line support (billing, ordering, shipment tracking etc.) for physical goods.	Additional requirements to manage the delivery of products/services assembled from multiple sources.
After-sales support infrastructure	Provide after sales service and support.	"Need-based" and "time-bound" partnerships between suppliers make the task of providing after-sales support a challenging one.

Table 4.2: E-Commerce system requirements and extensions for multi-enterprise e-business

Table 4.2 shows that the extensions for multi-enterprise e-business are primarily due to the increased number of entities in the business model and the need for real-time information access in a dynamic environment. The need-based and time-bound nature of business partnerships adds to the complexity and coordination overhead.

4.8.2 New System Requirements for Multi-enterprise E-business

In addition to the extensions outlined in Table 4.2, a number of new requirements for multi-enterprise e-business have been identified, as a result of customer needs. Table 4.3 outlines these new system requirements and defines them.

System Requirement	Definition
Formation and flexibility	Establishing a multi-enterprise alliance *dynamically*, based on customer requirements [3]. Being responsive to changing customer needs.
Increased coordination	Controlling, ordering, and coordinating the activities of the multi-enterprise e-business coalition(s) in a dynamic environment.
Extensibility	It must be easy to integrate new businesses into the multi-enterprise framework (supplier "plug & play")
Comparative efficiency	Cooperation and communication overhead should not have an impact on turnaround time. It should be more efficient for a customer to deal with a multi-enterprise than with each individual firm.

Table 4.3: New System Requirements for Multi-enterprise E-business

The system requirements listed in Table 4.3 are specific to the dynamic nature of multi-enterprise e-business. Forming alliances based on customer needs and making it an efficient form of doing business are key system requirements. They define the essence of a multi-enterprise e-business model.

4.9 Architecture

Based on the system requirements listed in the previous section, the architecture of the system will be developed in the next chapter. We will develop a functional model of the system and focus on the architecture of the e-broker. We will also look at various operational scenarios of the system.

4.10 Summary

In this chapter, we developed the problem statement and also analyzed existing implementations of e-broker systems. We developed a classification system for e-broker implementations. We identified key customers of multi-enterprise e-business systems and listed their needs. We also identified system requirements for multi-enterprise e-business systems. In the next chapter we will develop the architecture for such systems.

5 Architecture

5.1 Preview

This chapter will develop a functional model and e-broker architecture for a multi-enterprise e-business system. The functional architecture will focus on identifying the various actors in the system and partitioning of the system into different functional components. It will also analyze the value chain based on the actors and their functionality. The e-broker architecture will go deeper and identify the components of various functional blocks that are needed to implement the required functionality. It will also identify the interfaces and communication between various elements of the system. We will also look at various operational models of the system.

5.2 Functional Architecture

5.2.1 Actors

Actors are defined as distinct groups of entities that seek or provide functionality from or to a multi-enterprise e-business system. The primary actors in a multi-enterprise e-business system are listed in the following sections.

5.2.1.1 External customers

External customers seek goods and services from a multi-enterprise e-business system. They expect search and selection functionality in addition to a number of support activities. One of the primary expectations of external customers is that a multi-enterprise e-business system should provide a seamless front and hide the complexity of doing business with multiple suppliers on an individual basis.

5.2.1.2 Suppliers

Suppliers are the providers of goods and services in a multi-enterprise e-business system. These goods and services are supplied in response to customer needs. Suppliers may be internal to the system or external. Internal suppliers may be those that have been part of the multi-enterprise e-business system for a while and have done business using its framework. External suppliers may be those that are pulled into the system to satisfy a particular need that cannot be satisfied internally. External suppliers might be sourced through another broker or independently.

5.2.1.3 E-broker

An e-broker provides the framework for conducting multi-enterprise e-business. It provides a number of automated services to external customers and internal and external

suppliers. Most of the requirements of multi-enterprise e-business identified in chapter 4 are satisfied by an e-brokerage. E-brokers coordinate all activities and provide the glue that holds a multi-enterprise e-business system together.

5.2.1.4 Support Service Providers

Support services include installation, administration, and maintenance of the required hardware and software infrastructure. They also include logistics suppliers, payment processing and banking services, and post-delivery support services. Their activities are coordinated by the e-brokerage.

5.2.2 Actors in the Value Chain

An e-broker-assisted multi-enterprise e-business value chain has been developed in section 4.3.3. Figure 4.3 shows the various stages and functionality of the value chain. An e-brokerage impacts all stages of the value chain including the attract, interact, act and react stages. External customers are involved in the interact and react stages. Suppliers are involved in the interact stage for capacity assessment, and in the act stage for provision of goods and services. Logistics and customer support providers are involved in the act and react stages to manage orders and provide customer service, respectively. Infrastructure, hardware and software providers and maintenance organizations are involved across the breadth of the value chain. Figure 5.1 is a revised version of Figure 4.3 that shows the primary actors involved in different stages of the value chain based on the discussion above.

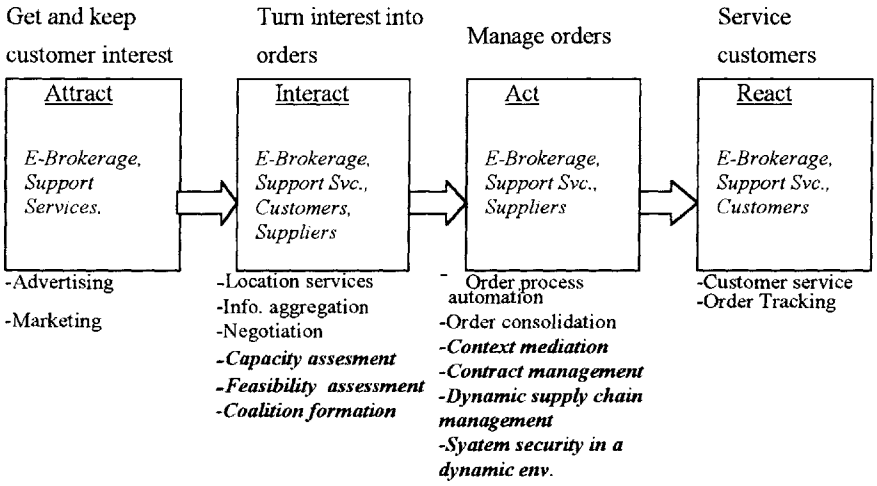


Figure 5.1: Primary actors in different stages of the value chain

5.2.3 Functional Model

A functional architecture of the multi-enterprise e-business system identifies various levels of functionality and the interfaces between them. This model is an extension of the framework presented in [9]. Our model extends the functionality presented in [9] by placing more emphasis on e-broker functionality, and leveraging internal and external suppliers on an as-needed basis. The interfaces between the e-broker and customers, suppliers, and service providers provide added functionality in order to enable multi-enterprise e-business. Figure 5.2 shows this extended functional model and how the actors identified in section 5.2.1 map to this model.

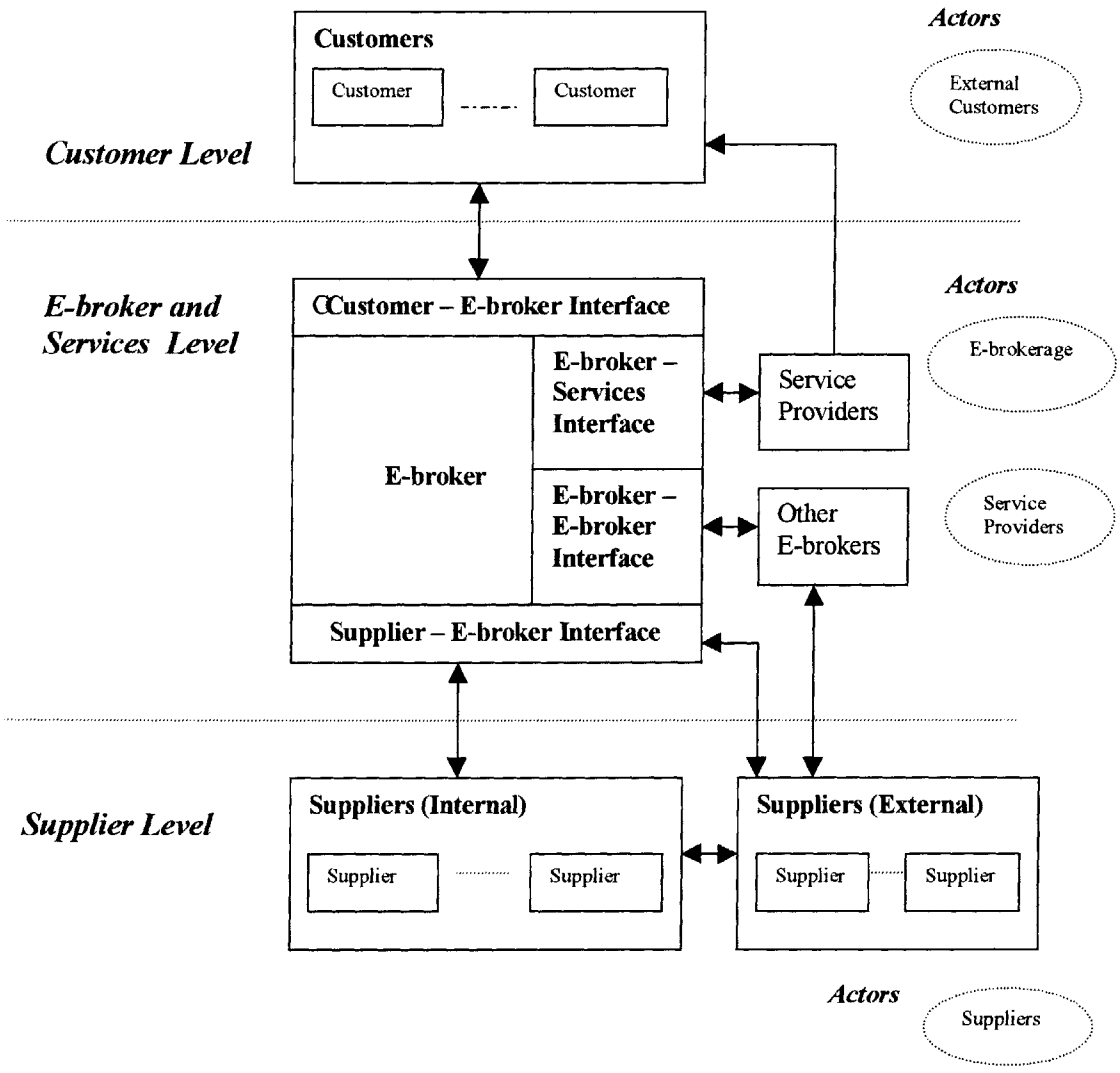


Figure 5.2: A functional model

The customer level includes external customers of the multi-enterprise e-business framework. Customers interact with the e-broker through the customer-e-broker interface and also receive service from external service providers whose activities are coordinated by the e-broker. The "external customer" actors map to this functional level.

The e-broker and services level encapsulates most of the functionality of multi-enterprise e-business. It controls the interfaces to customers and suppliers as well as other e-brokers and service providers. This level coordinates all activities of the multi-enterprise e-business framework. The "e-broker" and "service provider" actors map to this functional level.

The supplier level includes suppliers internal to an established multi-enterprise e-business framework, and external suppliers that may be leveraged on an as-needed basis. Supplier coalition formation is controlled by the e-broker that sets up communication channels between suppliers and also monitors their activity. The "supplier" actors map to this functional level.

In the next section we will analyze the internal architecture of the e-broker and services level component of the functional architecture. This piece forms the backbone of a multi-enterprise e-business framework.

5.3 E-broker Architecture

The e-broker and services level forms the most critical piece of a multi-enterprise e-business architecture. In this section we will decompose the internal architecture of the e-broker, which is responsible for coordinating all activities of a multi-enterprise e-business.

In order to categorize different elements of the e-broker architecture, we will adopt the layered approach for electronic commerce services introduced by the OSM (Open Services Model [50]) architecture in [5]. The three layers of this model are shown in Figure 5.3 [5].

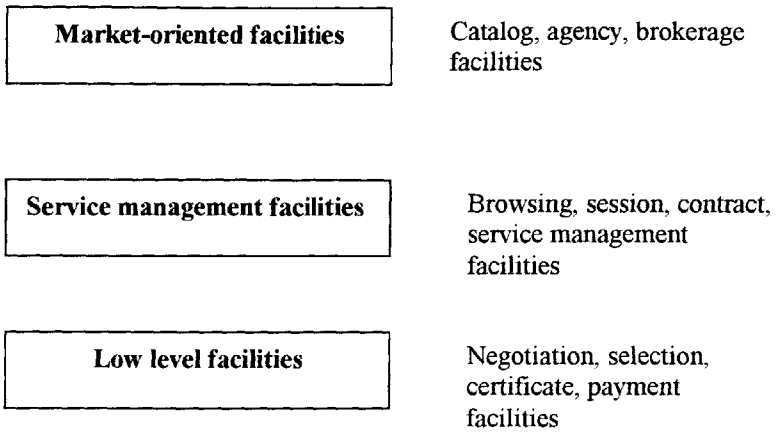


Figure 5.3: The layered OSM architecture [5]

The three levels of the OSM architecture shown in Figure 5.3 encapsulate different facilities for e-commerce. Market oriented facilities allow the cataloging of offerings and an agency facility to query this information. They also include brokerage facilities to enable privacy, advertising, and trading services. Service management facilities manage the contract and delivery aspects of services provided to customers and to participating businesses. The low-level facilities include infrastructure services in order to provide a secure and convenient forum to conduct on-line business. This includes secure payment services, policy enforcement, and negotiation support.

Using the e-broker outline presented in Figure 5.2 and the layered approach shown in Figure 5.3, we will now decompose and categorize the various architectural components of an e-broker for multi-enterprise e-business systems. Figure 5.4 shows the different architectural components, their aggregation into the three levels of Figure 5.3, and the communication channels between these levels and the various interfaces.

This is a hierarchical breakdown where the market oriented facilities leverage the service management facilities, which in turn leverage the low-level facilities. The service management facilities perform the bulk of the coordination work by interfacing with external service providers as needed, and external e-brokers when outside competencies need to be leveraged.

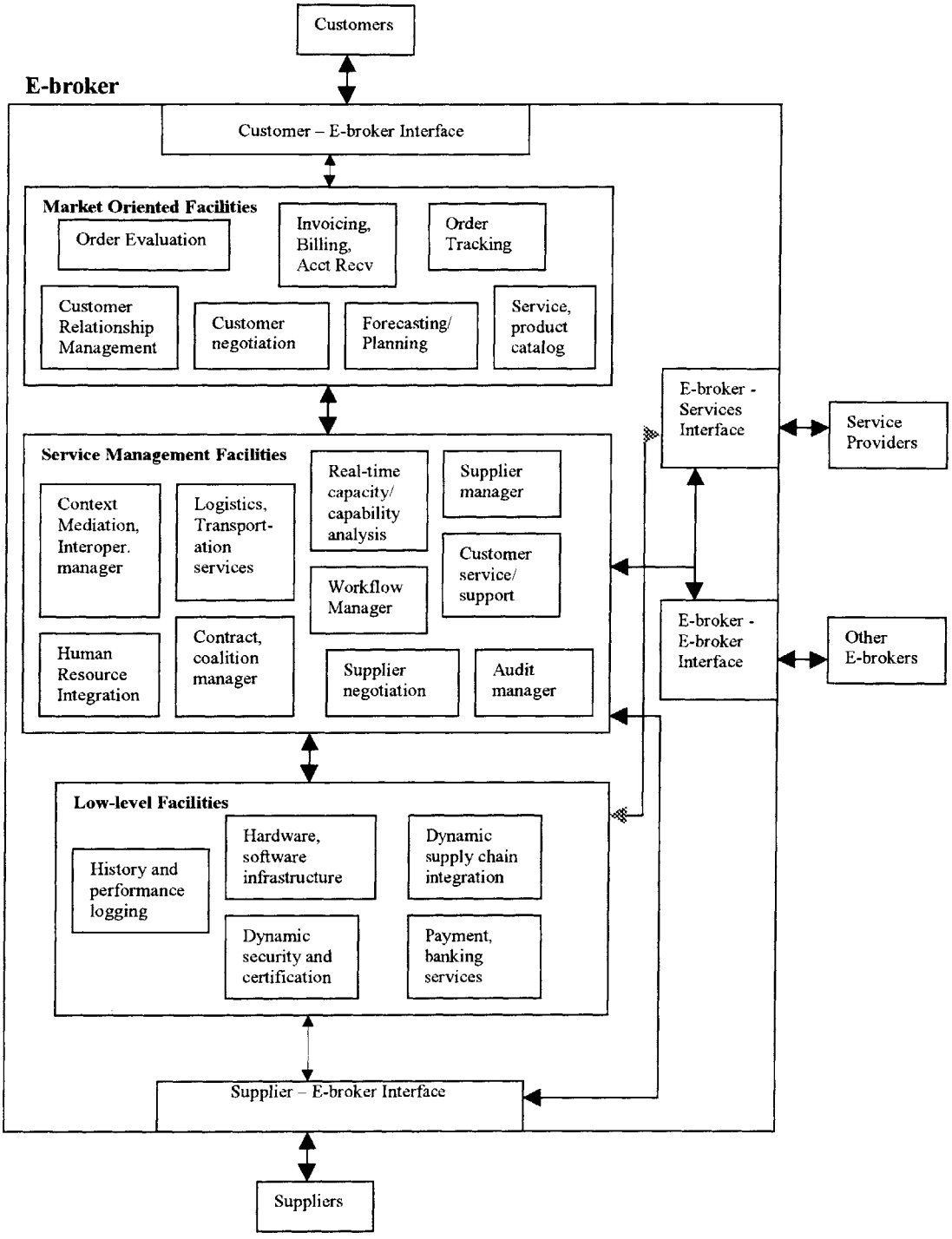


Figure 5.4: E-broker architecture

Table 5.1 lists the architectural components of the market-oriented facilities and their functionality. This piece of the architecture interfaces with external customers and market services. It provides customer interaction services in addition to order evaluation, cataloging, invoicing, and order tracking services. It also provides forecasting and planning functionality based on market scenarios. It leverages the service management facilities for providing the functionality essential for most of these services.

Architectural Component	Role
Order evaluation	Evaluate the feasibility of customer order based on an assessment of competencies and capacities. Identify external competencies that might need to be leveraged. Determine timeframe for order completion.
Invoicing, billing, account receivables	Present consolidated invoice and billing information to customers. Provide account receivable services to receive and distribute payments.
Customer relationship management	Provide customer relationship management tools to build and enhance relationships with customers. Make it convenient and easy for customers to do business with.
Order tracking	Provide customers with a window into the supply chain and logistics services in order to allow them to track the status of their orders.
Customer negotiation	Provide negotiation services between the e-broker and customers for cost, time, and feature tradeoffs. This also interfaces to the supplier negotiation functionality at a lower level.
Forecasting, planning	Gather market data and customer order statistics to forecast and plan for future orders and demand. Provide this information to suppliers.
Service, product cataloging	Provide a comprehensive catalog of supplier offerings and capabilities based on individual suppliers and coalition formation. Provide real-time updates based on capacity analysis.

Table 5.1: Market Oriented Facilities

Table 5.2 lists the architectural components of the service management facilities and their corresponding role. The bulk of the e-broker functionality is concentrated in this set of facilities. It includes real-time capacity/capability analysis, contract and coalition management functionality, supplier management, and negotiation components. It also includes services for logistics and transportation management, as well as support for workflow breakdown and monitoring. This set of facilities also includes support for context mediation and interoperability in order to ensure seamless flow of information across various entities in the multi-enterprise e-business framework.

Architectural Component	Role
Logistics and transportation services	Communicate with internal and external service providers to coordinate logistics and delivery processes. Provide tracking services across the value chain.
Context mediation and interoperability manager	Provide automated context mediation services to ensure error-free information interchange between various entities. Provide the interoperability infrastructure to enable real-time document and information exchange.
Contract, coalition manager	Enable supplier coalition formation to support customer requirements. Provide a legal contract formation framework to establish coalitions.
Human resource integration	Allow the integration of human knowledge as appropriate, through the external service provider interface.
Real-time capability/capacity analysis	Provide real-time analysis capability across the supply chain and across all available suppliers. Leverages the integrated supply chain facilities provided at a lower level.
Workflow manager	Perform work breakdown and assignment. Also monitor work in progress and assist in final integration for customer delivery.
Supplier manager	Register new suppliers and their capacity/capability status. Maintain a performance record of suppliers (leverage low level history facility).
Supplier negotiation	Provide negotiation services between suppliers in order to support coalition formation.
Customer service/support	Provide post-sales customer service and support facility via internal or external service providers.
Audit manager	Provide auditing services in order to evaluate supplier performance, customer service, and payment issues.

Table 5.2: Service Management Facilities

Table 5.3 lists the architectural components of the low-level facilities and their corresponding role. These facilities also interact with external service providers in order to leverage external competencies. For example, payment and banking services may be outsourced to a financial service provider. This set of facilities includes support for recording transactions, providing a secure business environment, making the required software and hardware infrastructure available, and providing the means for dynamic supply chain integration.

Architectural Component	Role
History and performance logging	Provide means to log supplier performance on customer orders and a history of past work done. Used in supplier certification and analysis of customer orders.
Hardware and software infrastructure	Provide access the necessary hardware and software to coalitions in order to aid interoperability and increase efficiency in fulfilling customer orders.
Dynamic security and certification	Provide a secure operating environment in order to provide customer data and maintain protection of intellectual property and privacy. Ensure data security across different supplier coalitions.
Dynamic supply-chain integration	Provide the means to integrate the supply chain across a number of internal and external suppliers as required by different coalitions that might be formed.
Payment, banking services	Provide payment and banking services via internal or external providers, to suppliers and customers.

Table 5.3: Low-level Facilities

5.4 Operational Architecture

There are a number of operational sequences in a multi-enterprise e-business framework that are of particular interest. We will look at the following operational sequences in detail:

- Customer order evaluation
- Coalition formation

In order to analyze these operational sequences, we will identify the steps involved in each operation and develop UML (Unified Modeling Language) [51] models for each. This will help us analyze the sequence of actions and the actors involved at each stage.

5.4.1 Customer Order Evaluation

Customer order evaluation in a multi-enterprise e-business framework differs from a traditional e-commerce system due to the need for real-time capacity and capability analysis across candidate internal and external suppliers. Tight integration of information across suppliers, access to external suppliers, and integration of external suppliers on-the-fly, makes this possible. Based on the current commitments made by an e-broker to other customers, and available capabilities and capacities, a customer order may or may not be feasible. Figure 5.5 shows a UML collaboration diagram for customer order evaluation.

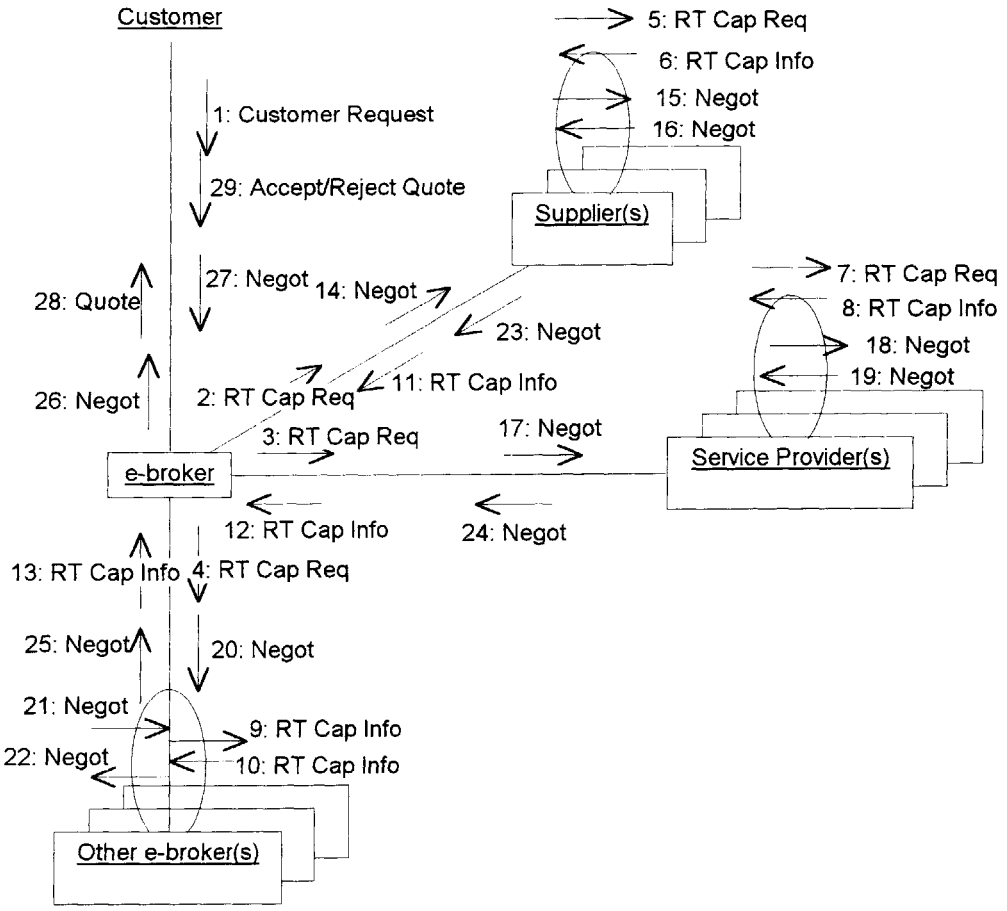


Figure 5.5: Order Evaluation Collaboration Diagram

All actors identified in section 5.2.1 play a role in the order evaluation process. This includes an external customer, the multi-enterprise e-broker, service providers, and suppliers. Also, the e-broker might leverage an external e-broker on an as needed basis. Following the sequence of messages sent between the different entities, we can see that

the process is kicked off by an order request from the customer to the e-broker. When the e–broker receives an order request, it performs an initial work breakdown and selects candidate suppliers based on it's knowledge of suppliers registered within the system. If it does not find appropriate internal suppliers, external suppliers may be contacted directly or via other e-brokers. This preliminary selection of suppliers, which might include more than one supplier for the same functionality, are sent requests for a real-time status update on their current capacities and capabilities in order to satisfy customer requirements. Suppliers, in turn, can leverage other internal or external suppliers and can initiate a capability and capacity analysis process among them. Similar capacity and capability analysis can take place with service providers and external e-brokers. Once the e-broker receives capability and capacity information from suppliers, service providers, and external brokers, it can initiate negotiations with the suppliers, service providers and external brokers on financial terms and time commitments. These negotiations can be an iterative process. Once these negotiations are completed, the e-broker initiates negotiations with the customer based on cost, features, or timeframe issues. Again, these negotiations could be iterative. Once this process is concluded, the e-broker puts together a final quote for the customer. The customer evaluates this quote and communicates an acceptance or rejection indication to the e-broker. Figure 5.5 shows the communication between different entities involved in the order evaluation process, as described above.

It should be noted that the representation shown in Figure 5.5 is one example of how events might proceed with respect to time. The interactions can be significantly more complex with multiple events taking place in parallel with multiple levels of iteration. Figure 5.6 shows a simple time ordering of these events. Again, this could be significantly more complex as multiple activities could be conducted in parallel.

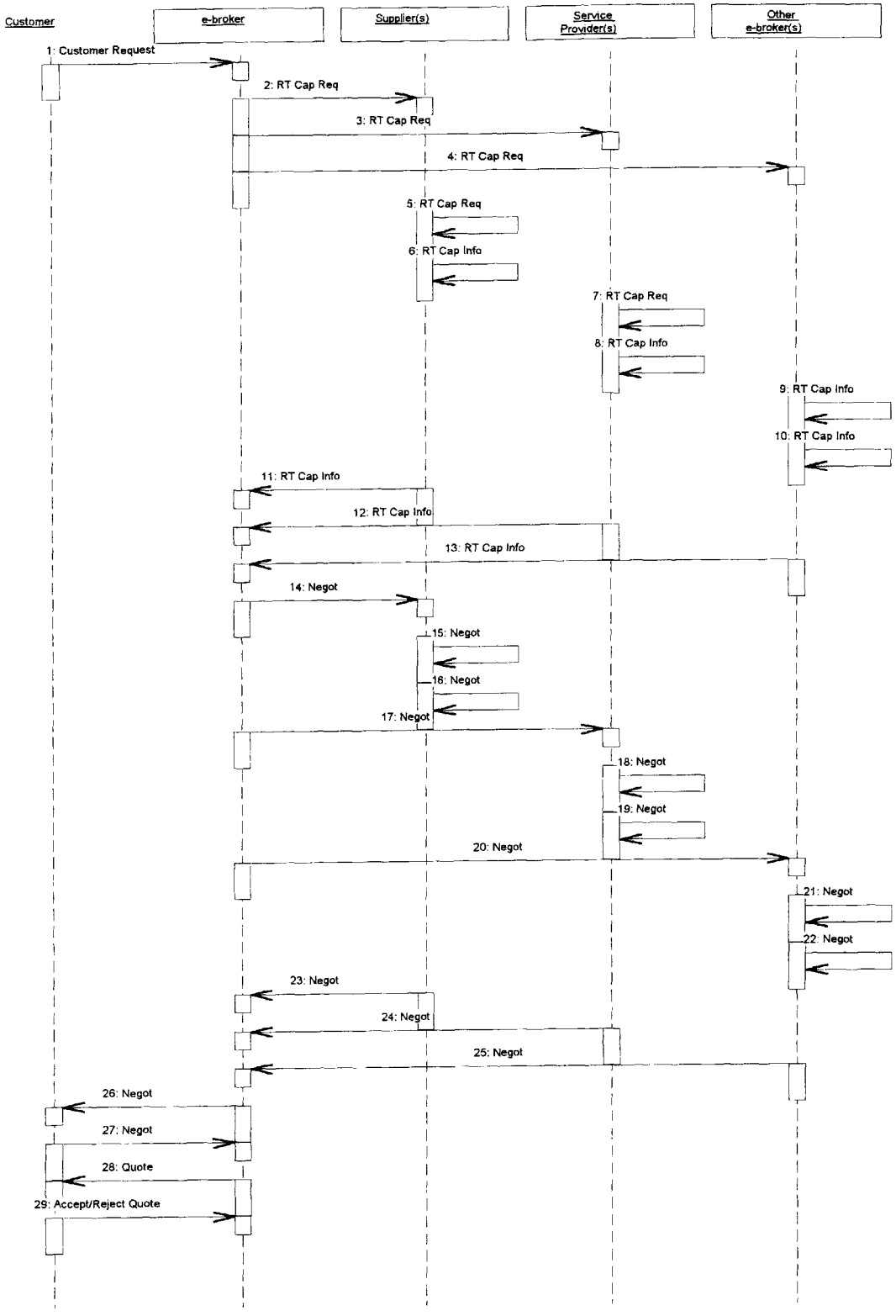


Figure 5.6: Order Evaluation Sequence Example

As part of this sequence of actions, the e-broker invokes a number of the market oriented, and service management facilities that were presented in Figure 5.4. Table 5.4 shows some of the architectural components that are invoked at each stage.

Order Evaluation Stage	Market Oriented Facility	Service Management Facility
Order reception	Service/Product Catalog; Customer Relationship Management; Order Evaluation	Context mediation
Initial work breakdown	-	Workflow manager
Initial supplier selection	-	Supplier manager; Workflow manager
Capacity/Capability Analysis	-	Real-time capacity/ capability analysis; Context mediation
Supplier negotiation	-	Supplier negotiation; Context mediation
Customer negotiation	Customer negotiation	Context mediation
Quote Preparation	Order Evaluation	Context mediation

Table 5.4: Order Evaluation – Architectural Components Invoked

5.4.2 Coalition Formation

Upon acceptance of the quote by the customer, the e-broker starts a coalition formation process. Supplier negotiations for cost and timeframe were completed during the order evaluation process. The coalition formation process begins with the e-broker integrating any new suppliers, service providers or other e-brokers and initiating contract negotiations. The suppliers, service providers, and e-brokers were selected during the order evaluation phase. Figure 5.6 shows a UML collaboration diagram of this process.

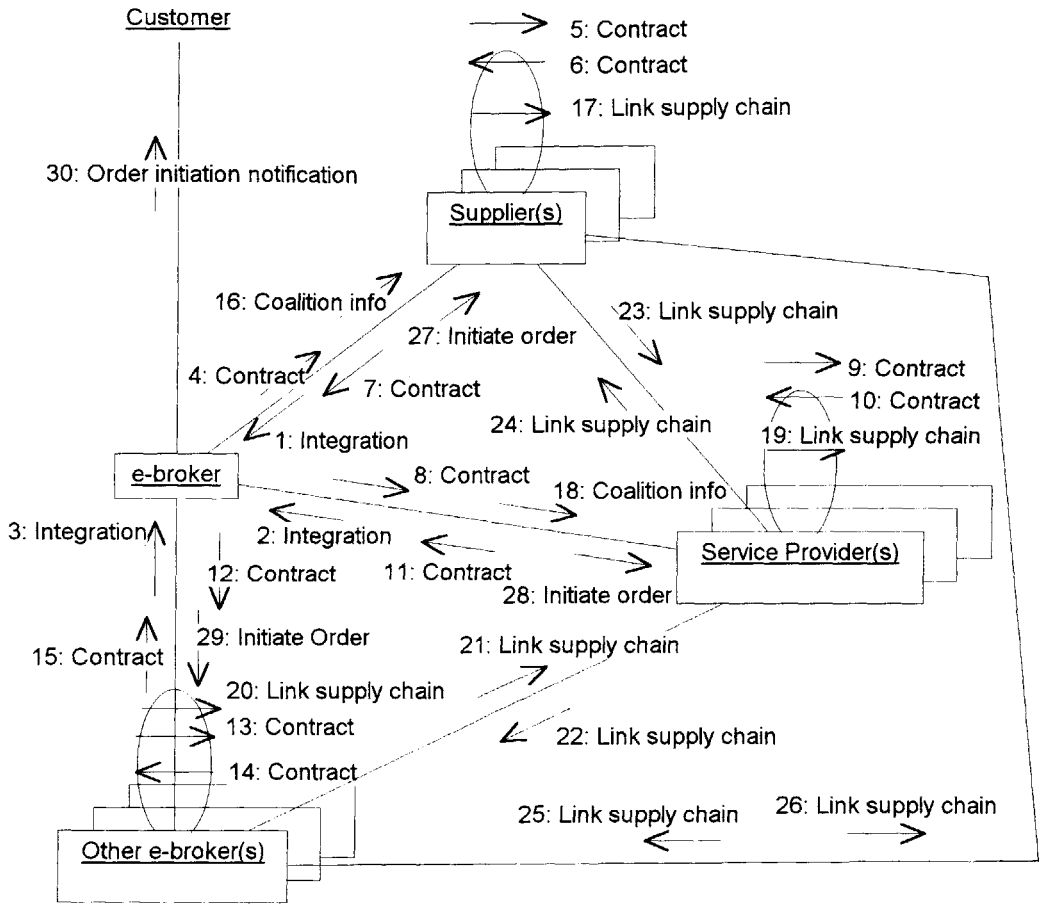


Figure 5.6: Coalition Formation Collaboration Diagram

As part of the order evaluation phase, coalition members were identified in order to service a particular customer order. Preliminary negotiations were also carried out with these entities. After the customer has approved the quote, the e-broker begins an integration phase where it integrates into the multi-enterprise e-business framework any new suppliers, service providers or e-brokers that are part of the coalition but are new to the framework. This integration process includes formal registration and information system linkage. After the integration process, an iterative contract step begins. During this step, the e-broker seals a contract with required suppliers, service providers, and external e-brokers. This has a cascading effect where suppliers and others can initiate contract processes with sub-contractors if need be. Once the contract process has been concluded, the e-broker informs all coalition members of their partners and initiates a process to dynamically link the supply chains of the coalition partners. After this process has been concluded, the e-broker instructs the coalition members to initiate order processing. It also informs the customer that order processing has been initiated. Figure 5.6 shows these interactions.

It should be noted that the representation shown in Figure 5.6 is one example of how events might proceed with respect to time. The interactions can be significantly more complex with multiple events taking place simultaneously with multiple levels of iteration. Figure 5.7 shows a simple time ordering of these events. Again, this could be significantly more complex as multiple activities could be conducted in parallel.

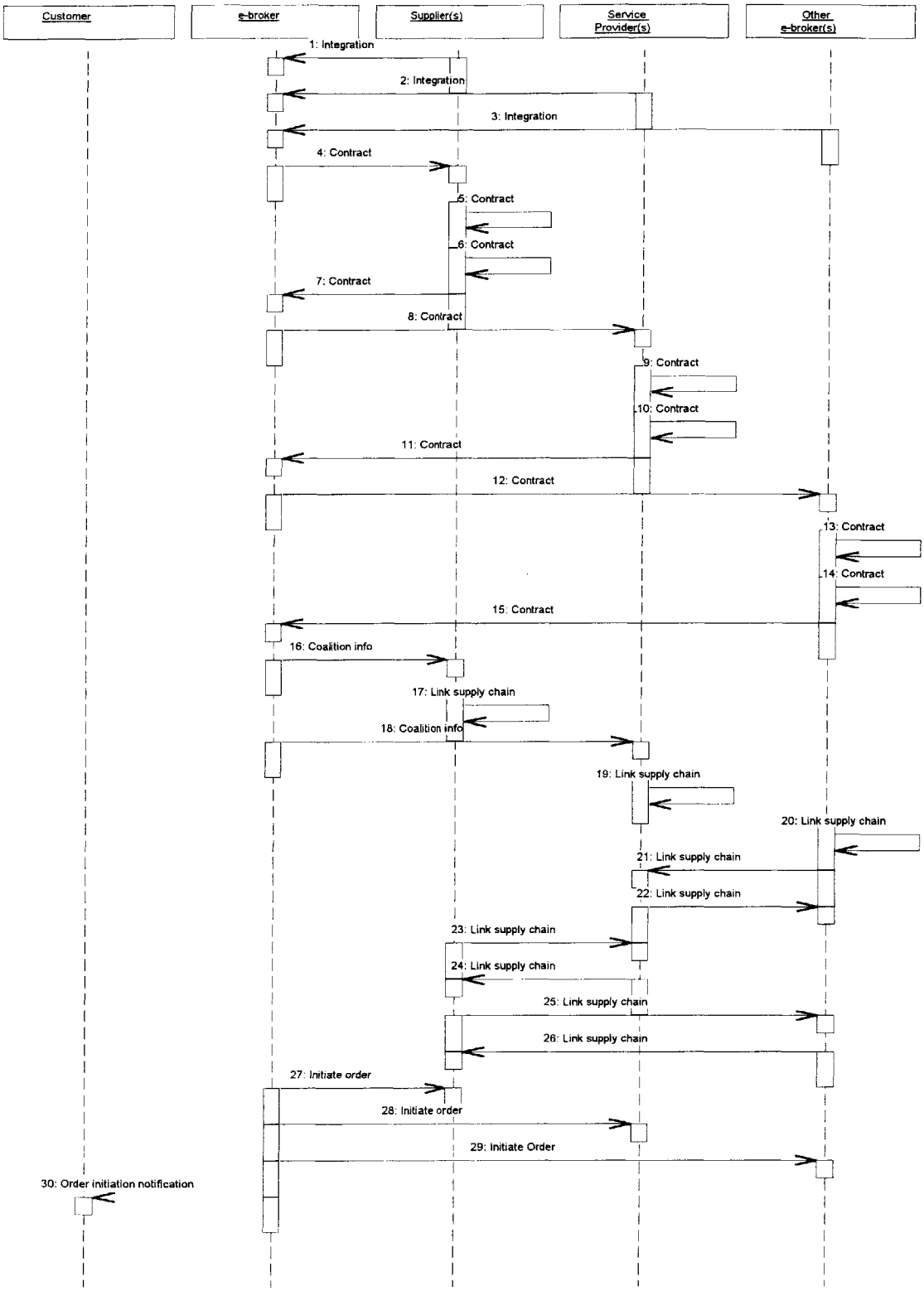


Figure 5.7: Coalition Formation Sequence Example

As part of this sequence of actions, the e-broker invokes a number of the market oriented, and service management facilities that were presented in Figure 5.4. Table 5.5 shows some of the architectural components that are invoked at each stage.

Coalition Formation Stage	Market Oriented Facility	Service Management Facility
Integrate new suppliers, service providers, links to other e-brokers	Service/product catalog	Supplier manager; Context mediation
Contract approval	-	Contract, coalition manager; Context mediation
Inform members of trading partners	-	Coalition manager; Supplier manager; Workflow manager
Dynamically integrate supply chain of coalition members	-	Supplier manager (leverage low-level dynamic supply chain integration facility); Workflow manager Context mediation
Provide secure environment for coalition to operate	-	Coalition manager (leverage low-level dynamic security facility)
Initiate order processing	-	Coalition manager
Inform customer of order initiation	Order Tracking	-

Table 5.5: Coalition Formation – Architectural Components Invoked

5.5 Summary

In this chapter we have developed a functional architecture for a multi-enterprise e-business framework. We started by identifying various actors in such a framework and then mapped them to the functional model. We analyzed the internal architecture of an e-broker and identified and categorized its various architectural components. Finally, we looked at two examples of the operational architecture by developing UML collaboration diagrams with the appropriate actors and mapping the different stages in each process to the architectural components of the e-broker that were invoked in that stage.

6 Case Study: mySAP.com

6.1 Preview

In this chapter we will look at a case study in order to analyze its implementation with respect to the multi-enterprise e-business model. Prior to that, we will develop an analysis framework to help us in comparing this case study to the multi-enterprise e-business model. Based on this framework, we will rate it and see how it scores with respect to the multi-enterprise e-business attributes we developed in Chapter 2.

Our case study looks at mySAP.com, an Internet portal form SAP AG [47]. The motivation for choosing mySAP.com as a case study is that it is probably among the first few Internet portals to provide services and infrastructure that are a pre-cursor to multi-enterprise e-business. This analysis helps contrast the state of the art in industry against our multi-enterprise e-business model.

6.2 Analysis Framework

In order to analyze the case study implementation with respect to our multi-enterprise e-business model, we need to develop a framework to rate various features. One possible way to do this is to score the case study implementation along each of the multi-enterprise attributes listed in Table 2.1. A score of "$\equiv$" for any attribute implies that the implementation meets the criteria for a multi-enterprise e-business model along that attribute. A score of "$\neq$" implies that the implementation falls short of the requirements (does not meet) for that attribute. A score of "$\varnothing$" implies that the requirements for that attribute are not present in the implementation in any form. Overall, this analysis framework is useful to get a quick overview of how an implementation compares with a multi-enterprise framework, rather than being a rigorous mathematical analysis of any kind.

We will use this analysis framework to rate mySAP.com with respect to our multi-enterprise e-business model.

6.3 mySAP.com

This case study analyzes a recently announced (late 1999) Internet business portal called mySAP.com [46] from SAP AG [47]. mySAP.com includes services for business-to-business procurement, business-to-consumer selling and business-to-business selling [46]. We will first outline the functionality of mySAP.com and then look at its architecture. We will then analyze mySAP.com from a multi-enterprise e-business perspective and evaluate its features from our perspective. Based on this we will enumerate a number of extensions to mySAP.com in order for it to enable multi-enterprise e-business.

6.3.1 Functionality

SAP's mySAP.com consists of four key elements that enable the functionality outlined below:

- **mySAP.com Marketplace**: The marketplace provides a medium for business-to-business buying, selling and information exchange.
- **mySAP.com Workplace:** The workplace provides users with a web-based personalized interface with access to all the tools that they need to do their job.
- **mySAP.com Business Scenarios:** Business scenarios are collections of applications that enable collaborative business-to-business solutions, business-to-consumer solutions, and interfaces to third-party software.
- **mySAP.com Application Hosting:** Provides hosting services for companies to access mySAP.com solutions.

For the purpose of this analysis we will focus on the "marketplace" and "business scenario" components. This functionality is most relevant in terms of multi-enterprise e-business.

6.3.1.1 mySAP.com Marketplace

mySAP.com Marketplace is essentially an Internet Web community hosted by SAP that aims to provide a one-stop destination for businesses to buy and sell goods and information. The functionality provided by the Marketplace can be outlined as shown in Figure 6.1.

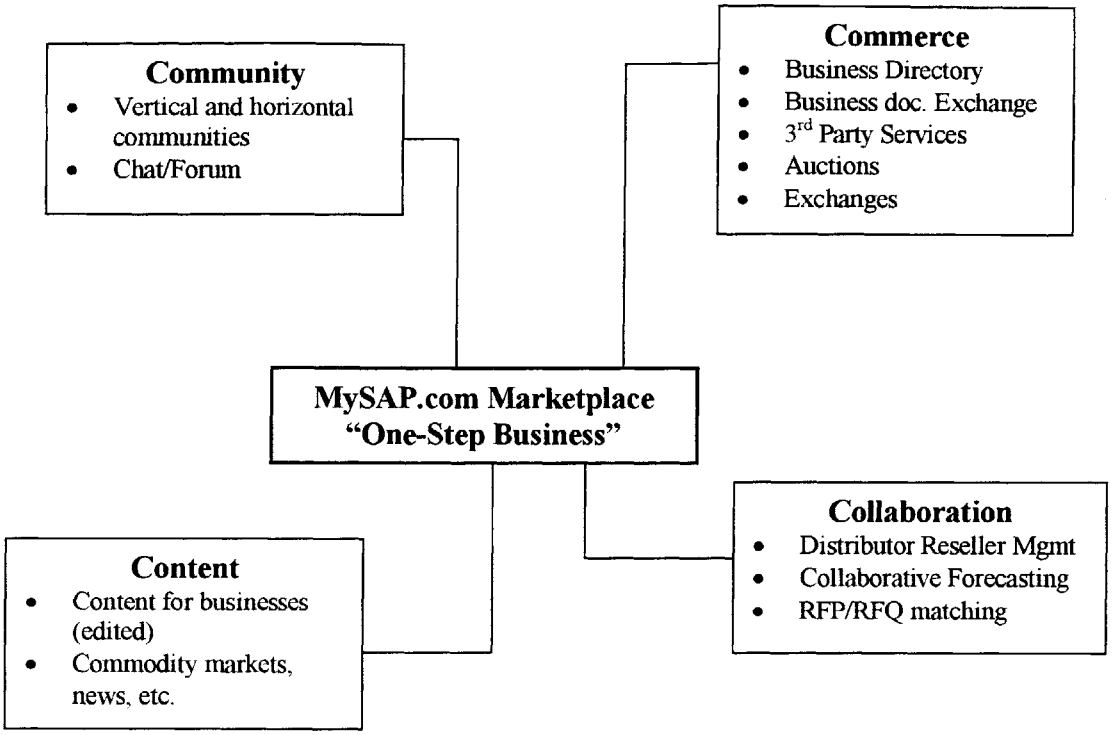


Figure 6.1: mySAP.com Marketplace Functionality [46]

Figure 6.1 shows four distinct areas of functionality: Community, Commerce, Collaboration, and Content. We will look at each one of these areas in which mySAP.com provides services.

Community services at mySAP.com include formation of vertical or industry specific marketplaces to meet the needs of businesses with similar interests like the oil and gas industry, for example. They also include horizontal communities for functions such as finance and human resources. These communities provide membership based access to tailored applications, content, and services.

Commerce services at mySAP.com include business directory infrastructure to provide information on buyers and sellers, product catalogs, contact information, and target market data. Companies can be categorized based on their offerings, in order to simplify the search process. This service addresses the buy-sell nature of e-commerce, although mySAP.com does provide addition collaboration services as described later. Figure 6.2 shows a typical buy-sell scenario on mySAP.com.

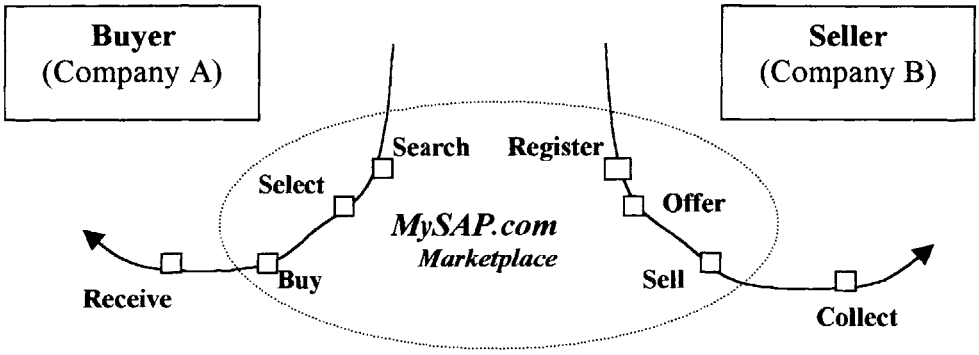


Figure 6.2: mySAP.com buy-sell scenario [49]

Commerce services also include a document exchange facility for buyers and sellers to exchange information. SAP also provides end-to-end ERP (Enterprise Resource Planning) integration services between buyers and sellers such that buyer and seller information (vendor or supplier master data) can be used to create records in ERP systems. This enables tighter integration at the purchasing and accounts payable level. Additional services such as exchanges and auctions provided by mySAP.com help customers liquidate excess inventory and have a targeted market forum in which to sell and exchange goods. Third party services include travel, career, and customer relations management services.

Collaboration services include Distributor Reseller Management (DRM) services that improve the process of initiating, negotiating, and finalizing agreements between manufacturers and their distributors or resellers. It provides integrity, timeliness, and administrative efficiency to this process. mySAP.com also provides services to manage the RFP/RFQ (Request For Purchase/Request For Quote) process by providing an infrastructure for posting, updating, distributing and matching RFP/RFQs. This enables a bidding framework to allow subcontractors to bid for contracts and for manufacturers to award contracts. This can be a cascaded service where primary contractors can present purchase requests or quote requests to sub-contractors and so on. This is one way of searching for suppliers and awarding contracts to suppliers that meet certain criteria. Figure 6.3 shows an example of mySAP.com's bidding framework.

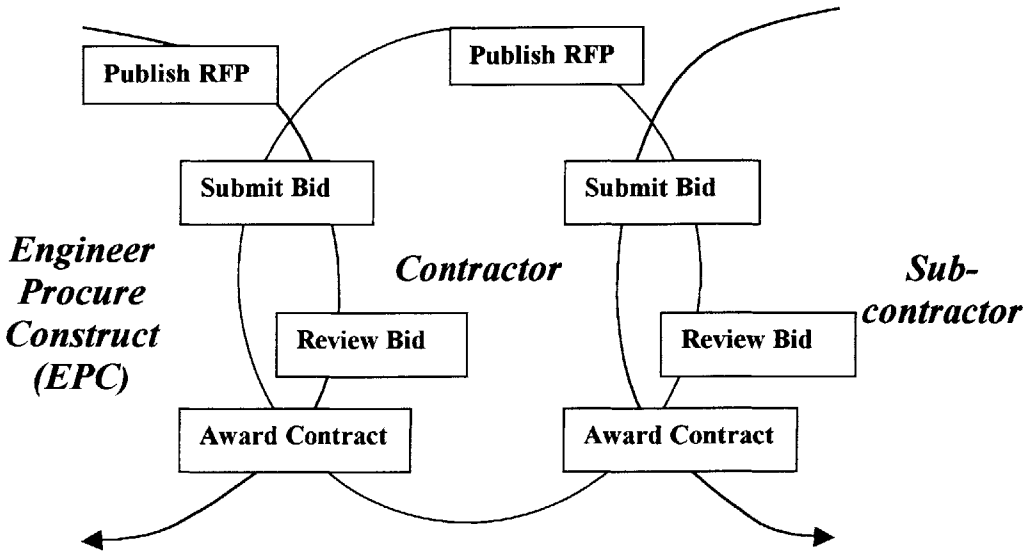


Figure 6.3: mySAP.com Bidding Framework [49]

mySAP.com also provides collaboration services in order to enable data exchange for planning purposes. For example, vendors and manufacturers can share sales forecasts and order forecasts through their ERP systems in order to collaborate on forecasting activities. This service also enables data exchange across heterogeneous ERP systems via a web-based architecture. Figure 6.4 shows the supplier collaboration framework of mySAP.com.

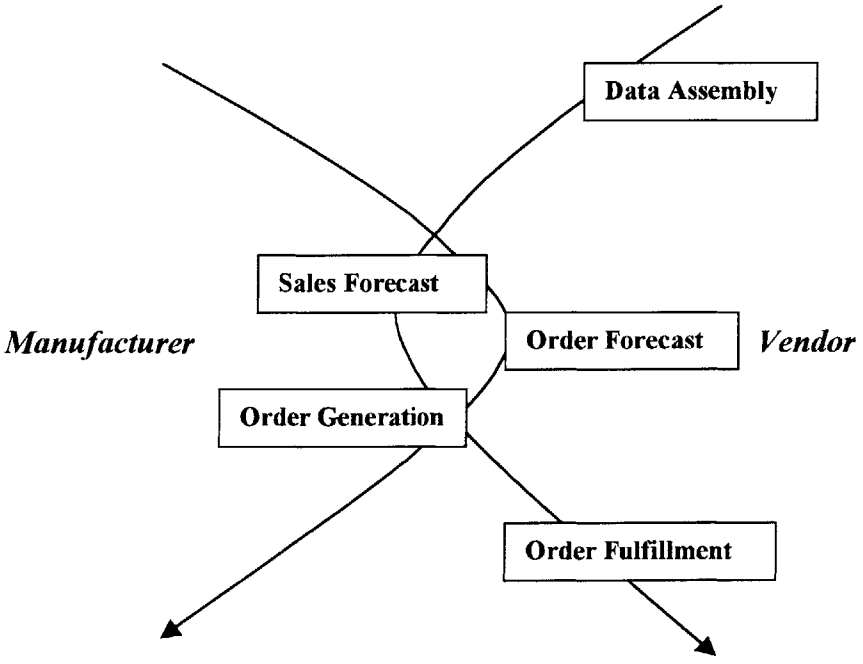


Figure 6.4: mySAP.com Manufacturer-Vendor Collaboration [49]

mySAP.com's content services aggregate different kinds of information in order to provide businesses with information on industry specific products and services. It includes content like analyst reports, industry trends, event information, and general news information like news, stock quotes, and weather. Chat rooms and hosted forums are also included in this service.

6.3.1.2 mySAP.com Business Scenarios

mySAP.com Business Scenarios are defined as end-to-end business processes that link customers, partners, suppliers, and vendors via the web. It essentially consists of software modules that can be deployed to enable specific business scenarios. These modules can cover the end-to-end process from requisition to approval to procurement. Business Scenarios support the operation of mySAP.com's Marketplace. Figure 6.5 shows the components of mySAP.com that enable various Business Scenarios.

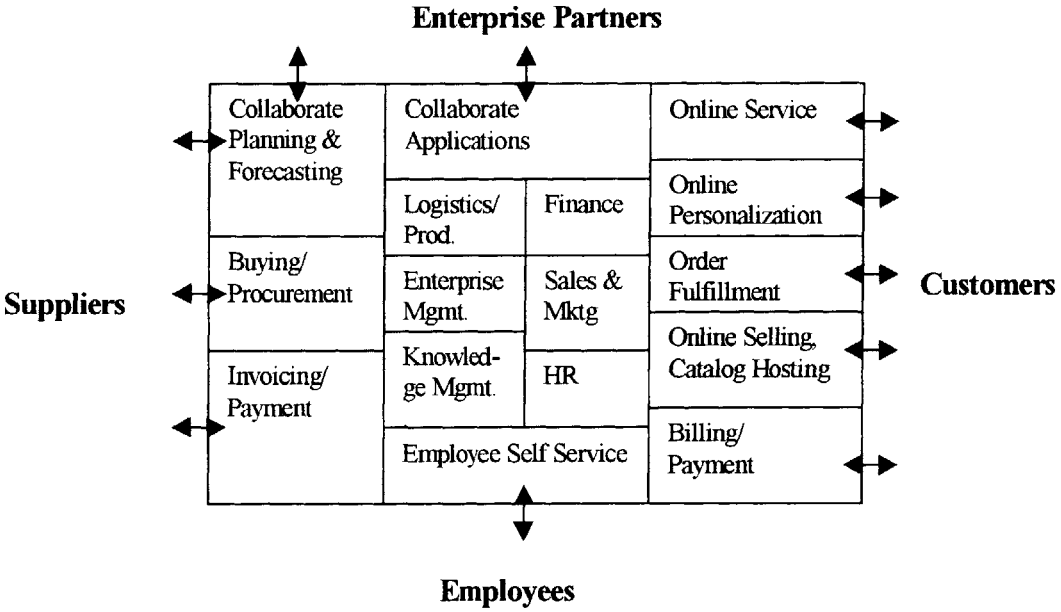


Figure 6.5: mySAP.com Business Scenario enabling components [46]

The components shown in Figure 6.5 enable a number of Business Scenarios. Some of the primary Business Scenarios are outlined below.

6.3.1.2.1 Vendor Managed Inventory (VMI)

In this scenario, a manufacturer is responsible for managing the inventory of a customer. The manufacturer collaborates with a supplier(s) and produces finished goods based on a number of parameters. These parameters include actual and projected demand of the customer, current inventory of the customer, and target days of supply for the customer. The manufacturer uses these parameters to proactively determining replenishment orders for the customer. By linking the manufacturer and customer planning and inventory systems, a high degree of automation is achieved.

6.3.1.2.2 Supply Network Planning

This scenario enables customers to plan supply chain production requirements and publish supply chain dependencies to their suppliers. The trading partners can then negotiate and agree upon a production plan. It also allows suppliers to update the plan, timeline, and other parameters based on changing conditions.

6.3.1.2.3 Supplier Collaboration

In this scenario, suppliers and manufacturers can collaborate on developing joint business plans. Sales and order forecasts can be created through a collaborative effort. Suppliers can thus synchronize their business plans and schedules as per a manufacturer's requirement. This allows for Just-In-Time delivery of components to manufacturers. Any changes to the plan can be quickly evaluated and schedules or manufacturing plans can be adjusted accordingly.

6.3.1.2.4 Customer Collaboration

Customer collaboration scenarios allow manufacturers and customers to share business intelligence data in order to improve demand planning capabilities. Customers have access to point of sale data, product offerings of different manufacturers and consumer behavior. Manufacturers, on the other hand, see various merchandising plans from a number of retailers. This scenario allows customers and manufacturers to share data in order to develop a single shared forecast of consumer demand.

6.3.1.2.5 Customer Relationship Management

This scenario involves customer relationship management (CRM) business processes. This starts out with the typical "persona" involved in each scenario. A "persona" is more than just a user. It involves the identification of unique needs, desires, and abilities which help determine how a given product or service is used. CRM tools help capture and analyze this kind of data. Core CRM functions include Internet sales and service, field sales and service, and Web-enabled customer service applications. Integration of catalog systems with backend systems is another aspect of this scenario, in order to anticipate current and potential customer requirements.

6.3.2 System Architecture

mySAP.com's focus on collaborative engineering and systems integration has led to a tiered architecture that enables different levels of collaboration. Figure 6.6 shows the layered approach to these different levels of collaboration [49].

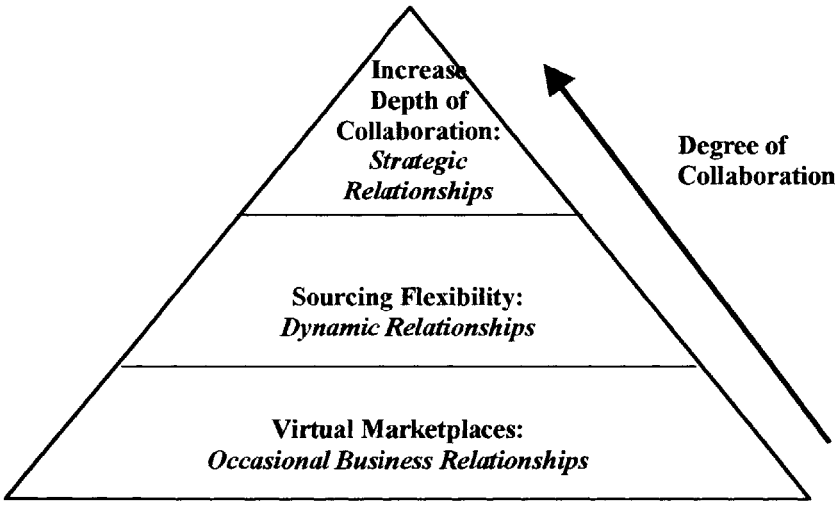


Figure 6.6: mySAP.com Tiered Architecture [49]

Virtual marketplaces essentially enable simple buy-sell e-commerce scenarios. These are occasional business relationships depending on current needs. These relationships typically involve commodity component sourcing in cases where there is limited complexity. The next level of collaboration involves dynamic relationships between firms in order to enable sourcing flexibility. Dynamic relationships might go deeper than typical buy-sell scenarios as they can depend on an evaluation of a supplier's current economies of scale in choosing suppliers. This implies tighter integration as compared to occasional business relationships. These relationships typically involve the sourcing of components of moderate complexity. Strategic relationships go beyond such relationships and are typically seen in cases where products are highly complex and require a high degree of cooperation amongst suppliers and manufacturers. Working towards designing a new car model is an example of such a relationship. This requires very tight integration between partners and their information systems.

The Marketplace is the key component of mySAP.com's system, from an analysis point of view. Figure 6.7 shows the architecture of the Marketplace.

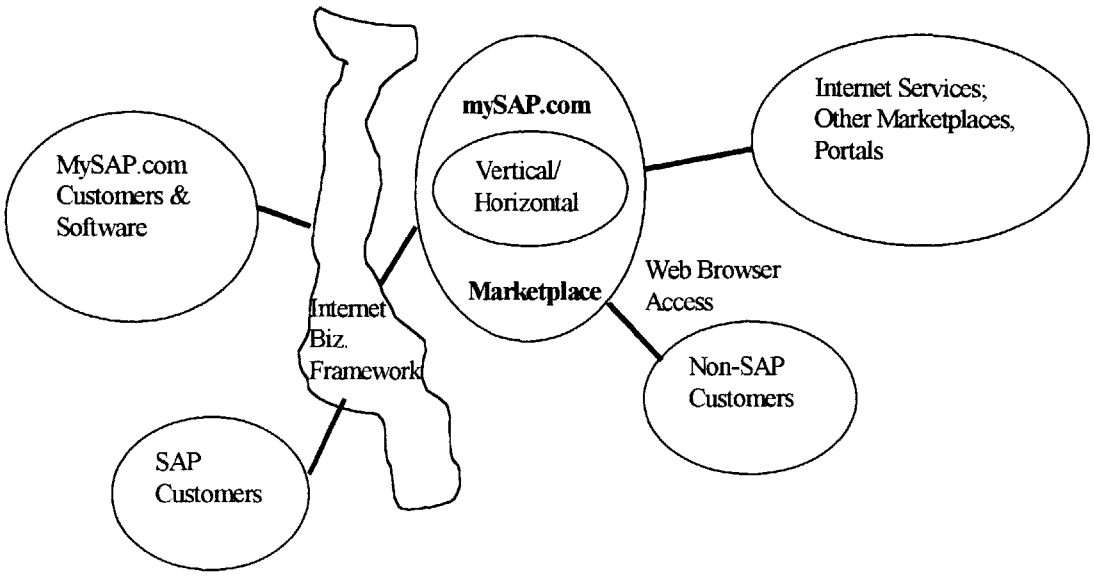


Figure 6.7: mySAP.com Marketplace Architecture [46]

The Marketplace enables integration of diverse (SAP and non-SAP) customers and suppliers. SAP systems are linked via an Internet Business Framework that links back-end and front-end systems for tighter integration. Other systems have web-based access to mySAP.com. This is an extensible architecture that taps into other marketplaces and portals to access external information as needed.

In addition to the marketplace architecture, mySAP.com provides personalized web access to users, from any location. It does this via a server-based management scheme that integrates various internal, external, SAP, and non-SAP components via appropriate middleware. This architecture is shown in Figure 6.8 below.

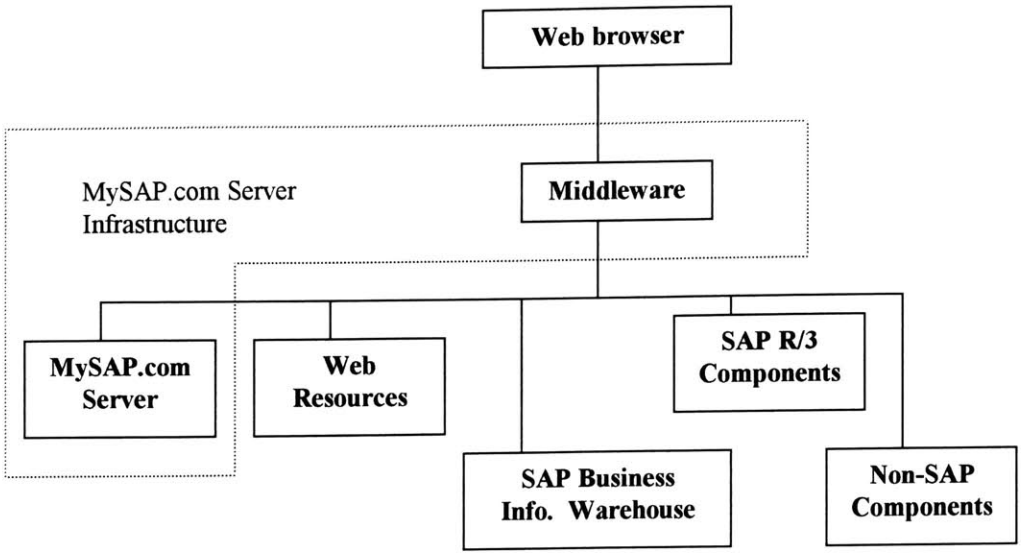


Figure 6.8: mySAP.com server based architecture[46]

The server-based management scheme allows mySAP.com to provide customized access to users regardless of their location. It uses middleware [58] to integrate different components to provide a seamless view.

6.3.3 Analysis

mySAP.com is one of the key innovators in terms of collaborative e-business. It has some of the features and attributes that characterize our multi-enterprise e-business model. We will now compare mySAP.com to the multi-enterprise e-business model. Based on this comparison, we will develop a set of extensions that would enable the implementation of our model on top of mySAP.com's existing infrastructure.

Table 6.1 shows the attributes of multi-enterprise e-business drawn from Table 2.1. For each attribute we evaluate mySAP.com. The scoring key, as described in section 6.2, is :

≡ implies that it meets the requirements
≠ implies that it does not meet the requirements (falls short)
∅ implies that the requirements are not implemented at all

Attribute	mySAP.com Analysis	Score
Real-time capability and capacity assessment across internal/external supply chain	MySAP.com Business Scenarios provide the ability to collaborate with partners and exchange information in real-time. Our model needs a **broker-assisted** capability to evaluate the feasibility of customer requirements to dynamically select appropriate	≠

	suppliers.	
Dynamic information aggregation	The ability of mySAP.com to integrate different ERP systems and back-end systems provides the means to aggregate information from various sources in real-time.	≡
Autonomous supplier "Plug & Play" – flexible supply chain	MySAP.com claims that it is easy for non-SAP businesses to hook into the framework and use Web-based communication to forge links with new suppliers. However, there does not exist a broker-assisted framework to seek out and integrate new suppliers or marketplaces depending on specific needs.	≠
Real-time status monitoring across internal/external supply chain	Real-time information exchange is possible through the integration of ERP and backend systems via mySAP.com. This allows for real-time status monitoring across the supply chain.	≡
Adapt to evolving customer needs	MySAP.com does not provide a broker assisted framework in order to provide a means of evaluating and adapting to changing customer needs. Business do have access to CRM tools in order to manage this process on their own. But a broker assisted coalition formation framework does not exist. This is an essential part of the multi-enterprise e-business model in order to form flexible business coalitions to suit evolving customer needs.	≠
Dynamic workflow partitioning	MySAP.com does not provide broker support for evaluating customer requirements, choosing the right suppliers, and allocation of work amongst them. These are some of the most critical steps in multi-enterprise e-business. The ability to dynamically partition and allocate work is crucial in order to ensure proper assimilation of the final product or service.	∅
Need-based time-bound partnerships	MySAP.com provides support for dynamic or occasional partnerships is via the RFP/RFQ process. Our model needs a broker assisted view of various suppliers and associated intelligence to aid in the formation of need-based or time-bound partnerships. There is a need for a broker-assisted framework to manage the administration of	≠

	creating and disbanding partnerships.	
Dynamic trust model	MySAP.com provides a secure environment for information exchange and document transfers between trading partners.	≡

Table 6.1: mySAP.com analysis along multi-enterprise e-business attributes

As Table 6.1 shows, mySAP.com provides the basic infrastructure and needs some extensions related to broker functionality in order to implement a multi-enterprise e-business model. In the next section we will propose a number of extensions to the broker functionality in order to enable a multi-enterprise e-business model in this scenario.

6.3.4 Extensions

As seen in the previous section, mySAP.com provides most of the basic infrastructure related to conducting multi-enterprise e-business. The key piece that is missing is enhanced broker functionality that is essential in providing a number of services critical to enabling multi-enterprise e-business.

mySAP.com's architecture is poised to provide such enhanced broker functionality. It already has the means to provide third party services like transaction tracking and secure document exchange services. Additional broker extensions should be able to build on the existing framework.

The enhanced broker functionality required for multi-enterprise e-business can be classified as follows:

- **Evaluate customer requirements:** mySAP.com should extend it centralized functionality to provide the means to accept customer requests and analyze them. This analysis should be based on currently available supplier competencies, economies of scale, capability, and capacity. It should be able to determine whether the supplier base can satisfy a customer's requirements in the given timeframe. If not, it should evaluate the possibility of leveraging external competencies as needed. The ability to analyze customer requirements for feasibility, in real-time, is critical to the multi-enterprise e-business framework.

- **Build appropriate coalitions:** After analyzing customer requirements, mySAP.com should be able to build a coalition of suppliers and manufacturers in order to satisfy the customer's needs in a timely fashion. This involves a number of administrative issues (partnership agreements etc.) that need to be handled by the broker. These coalitions could involve external suppliers or marketplaces as well. mySAP.com

should also provide the coalition monitoring and status update capability to customers.

- **Perform workflow partitioning and assignment:** Based on the previous two extensions, mySAP.com should have the ability to partition customer requirements into workflow chunks that can be assigned to different members of the coalition. This should be done such that the interfaces are clean and the right competencies and economies of scale are leveraged. The broker should track these work assignments on a regular basis such that final integration proceeds as planned.

- **Enable creation and disbanding of time-bound partnerships:** Coalitions formed by mySAP.com will be time-bound, by nature. They will last until the related customer requirements are satisfied. MySAP.com should provide the means for a coalition to disband after each member has completed its deliverable. However, the history of the coalition needs to be maintained in order to re-assemble the coalition for maintenance or customer support issues. These administrative tasks are the responsibility of the broker.

- **Seek out external competencies/capacity as needed:** mySAP.com should provide the ability to seek out external competencies and capacity as needed. Customer requests that cannot be satisfied by the existing supplier base could be satisfied if the appropriate external resources are sought. This extends the coalition formation and partnership-forging paradigm beyond the boundaries of the current mySAP.com Marketplace. The key functionality here is the fact the broker seeks out specific external resources in order to satisfy customer requests.

- **Provide customer service:** In the multi-enterprise e-business model, customers could be dealing with individual businesses or the central broker. For broker assisted e-business, it is essential that mySAP.com provide a framework for post-delivery customer service. Due to the nature of time-bound partnerships between suppliers and temporary coalitions, the broker needs to take on this responsibility. This implies that mySAP.com needs to put in place agreements with various suppliers regarding their service commitment and direct customer service issues to the right supplier(s).

In summary, these extensions to the centralized mySAP.com framework will enable a broker-based multi-enterprise e-business framework.

6.4 Summary

In this chapter we developed an analysis framework to rate various e-business implementations with respect to the multi-enterprise e-business model. We have analyzed a recently announced e-business initiative, mySAP.com, in order to compare the state-of-the-art with our multi-enterprise e-business model. We have identified its strengths and suggested extensions for it to enable multi-enterprise e-business.

7 Case Study: Dell Computer Corporation

7.1 Introduction

Dell Computer Corporation started in 1984 with a business model that bypassed dealer channels through which the traditional personal computer industry operated [31]. By selling to customers directly and building products to order, Dell achieved significant cost advantages and reduced inventory drawbacks.

Dell's business model is built upon a couple of familiar themes- customer focus, supplier partnerships, mass customization, and just-in-time manufacturing [31]. However, the combination of these elements and the use of technology have enabled new levels of efficiency and productivity through virtual integration. This business model implements some of the key elements of our multi-enterprise model, like an integrated supply chain and real-time information exchange with suppliers. In this case study we will analyze Dell's existing business model, see how it is similar to a multi-enterprise e-business model, and determine how additional elements of the multi-enterprise e-business model can impact its business.

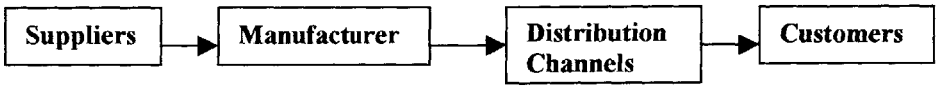
7.2 Dell's Business Model: Virtual Integration

Michael Dell, founder of Dell Computer Corporation, describes Dell's vertical integration model as "....you basically stitch together a business with partners that are treated as if they are inside the company." [31]. The essence of virtual integration is forging close links with a selected few suppliers and sharing information in real-time. This enables just-in-time manufacturing and a reduction or elimination of inventory in the pipeline from Dell's point of view. This paradigm can also be extended to the customer side of the equation in order to develop closer ties with customers.

On the supplier side, Dell treats its suppliers like internal providers. Component requirements are communicated on a daily basis as per system orders received from customers. Delivery requirements are communicated down to the exact time and dock of delivery. Information technology makes this sharing of information and databases possible, which in turn speeds up time to market. The emphasis in this model shifts from the amount of inventory that needs to be maintained to the rate at which inventory is moving. In the fast moving computer industry, being stuck with obsolete inventory due to product transitions, can result in a big cost disadvantage.

Figure 7.1 shows how Dell's model differs from the traditional reseller and distributor based personal computer industry model. It also shows how Dell's initial direct sell model evolved to a virtually integrated model that blurs the distinction between various components of the value chain. Information flows seamlessly and on a regular basis between the different entities of the value chain. Dell communicates with suppliers on a daily basis, or on an hourly basis in some cases.

Typical PC industry model: A value chain with arms-length transactions from one layer to the next



Dell's direct model: Eliminates third party distribution time and cost

Virtual Integration: Works faster by blurring traditional boundaries and roles in the value chain

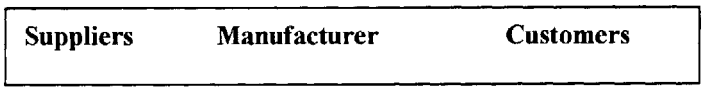


Figure 7.1: Evolution of a faster business model [31]

One of the key elements enabled by the virtual integration model shown in Figure 7.1, is build-to-order. As a result of close links with suppliers and just-in-time delivery of components and manufacturing, Dell can build a system to a customer's specifications upon receiving a customer order. Dell's build-to-order flow is shown in Figure 7.2.

Customer orders are received through one of three channels- online orders, telephone orders, and face-to-face sales. Once orders are received, suppliers are informed of the components needed to fulfill an order and the location and time of delivery for the components. Dell thus receives these components in a just-in-time manner so that it is ready to assemble the components as per a customer's order. The "kitting" process pulls together components delivered by various suppliers that were requested for a specific customer order. This results in a tote with all the necessary components for a given order. The subsequent assembly and testing processes get the system ready for the shipping and delivery process.

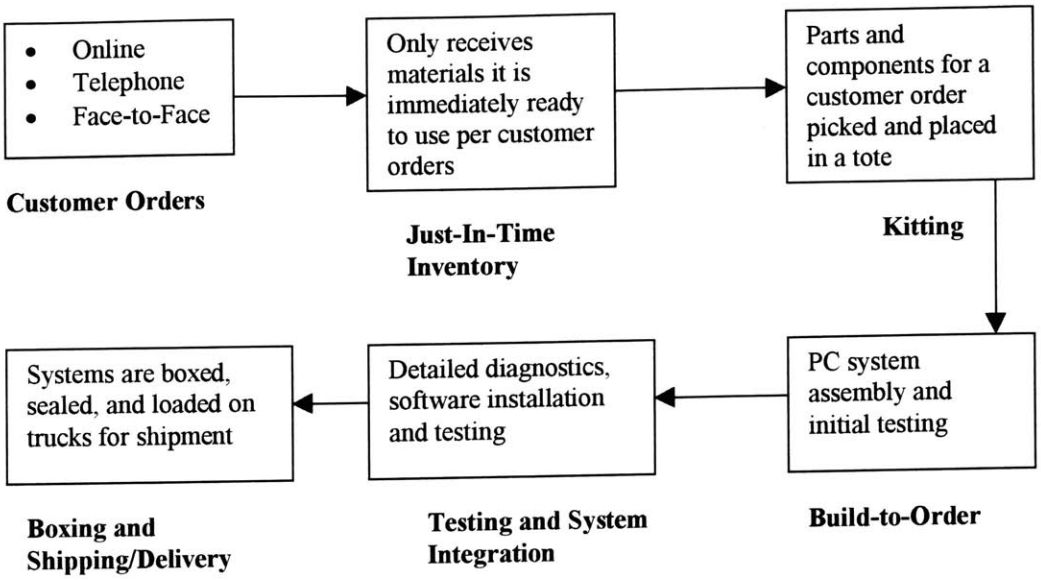


Figure 7.2: Dell's Build-to-Order Business Model [32]

7.3 Dell and its Suppliers

As part of its virtual integration model, Dell develops and maintains close links with its suppliers. Dell relies on its suppliers for component manufacturing rather than investing in manufacturing capacity itself. Dell's suppliers also include providers of services like shipping, delivery and on-site repair. Table 7.1 lists some of the key elements of Dell's relationship with its suppliers, based on [32].

Element	Description
Exploit external talents, investments, and expertise	Leverage external competencies from best-in-class suppliers instead of investing internally. This allows Dell to focus on areas where it can add most value and find suppliers to do the rest.
Limit number of suppliers	Dell focuses on building strong relationships with a small number of customers in order to foster close partnerships. This results in fewer opportunities for error, less cost, less confusion, and increases consistency. Less than forty suppliers supply Dell with more than ninety percent of its components.
Geographic or electronic proximity	Dell has determined that supplier proximity in geographic terms can be very beneficial because of reduced shipping costs and shorter transit times to exploit cost reductions. This is important because computer component costs drop steadily (1/2 to 1%) on a weekly basis. With suppliers that are not geographically close, electronic proximity is critical in maintaining a close relationship.
Set clear standards and metrics up-front	Quality standards and defect tolerance must be communicated at the outset of a relationship. Clear metrics should be outlined to evaluate on-

	going performance.
Focus on "inventory velocity"	Dell works with its customers to focus on how fast inventory is moving. It works with its suppliers to keep reducing inventory and to increase speed. The relationship with suppliers is based on build-to-order as opposed to build-to-plan. This leads to requests for daily and hourly component supply by Dell.
Establish direct and real-time communication channels	Dell does this by making sure that the right information reaches the right suppliers at the right time. For example, customer feedback about supplier components is communicated to suppliers in real-time. Also, logistics suppliers can be asked to match up Dell computers with monitors from another supplier and deliver them to customers. Timely and direct information exchange is critical for such tasks.
Share information with suppliers	Dell serves as a repository for quality data, inventory information levels, and technology plans that its suppliers can access. Web-based links allow Dell to share information in order to improve inventory velocity.
Collaborate on research and development	Dell's strategy is to evaluate component offerings from multiple suppliers, rather than developing them internally, and then choose and partner with supplier(s) by providing specifications and resources.

Table 7.1: Key elements of Dell's supplier relationships

As seen in Table 7.1, Dell's close links with its suppliers are the result of a high degree of real-time information exchange. This results from developing an integrated supply chain with suppliers and other service providers with whom Dell has pre-established partnerships.

7.4 Operational Overview

Figure 7.3 shows an operational overview of Dell's virtual integration model.

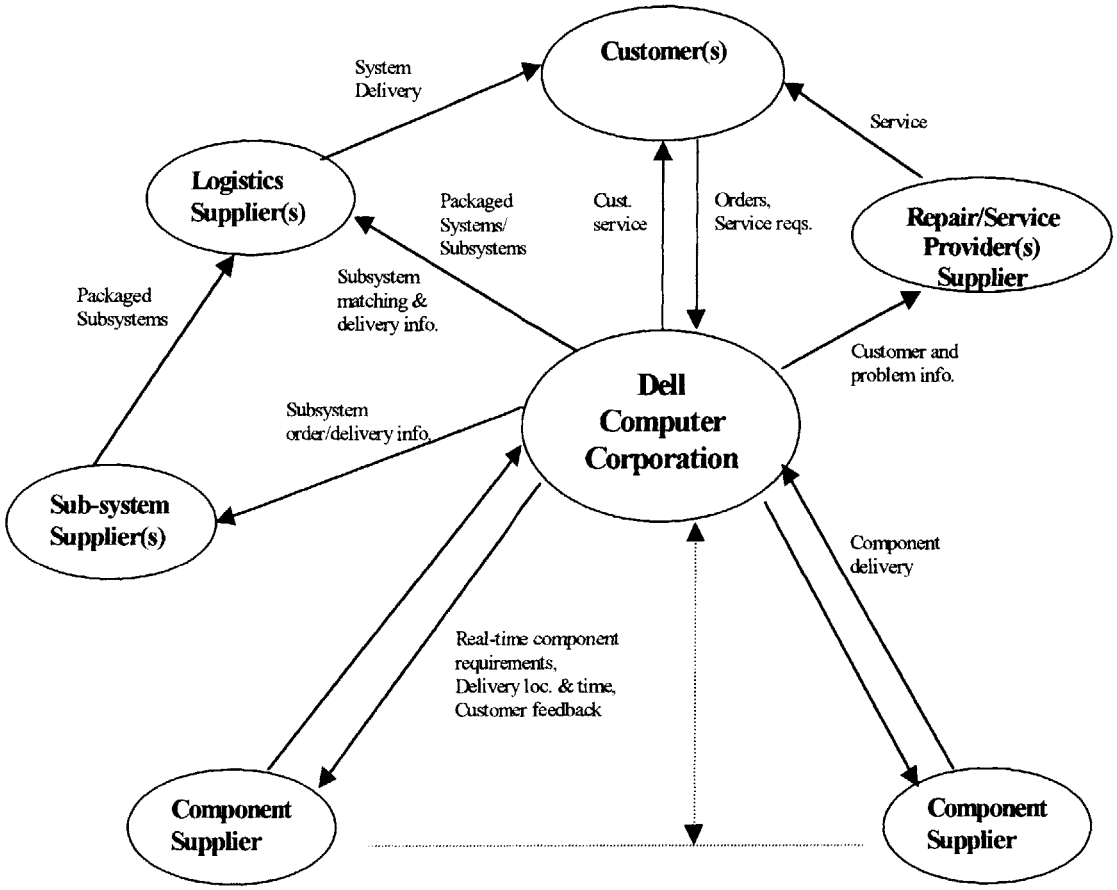


Figure 7.3: Operational overview of the Dell model

A pre-selected component supplier base receives real-time component orders from Dell with information on location and time of delivery. Dell derives this information from individual customer orders. Dell also communicates customer feedback on components back to the component suppliers in real-time. Due to the close partnerships Dell has forged with its suppliers, it has developed a high level of quality in terms of subsystem suppliers. This enables it to deliver subsystem requirements to subsystem suppliers and have them delivered directly to customers via a logistics provider. Monitors are a typical subsystem example in this type of a scenario. Logistics providers are supplied with a subsystem and information on order consolidation using subsystems from other suppliers. Dell also provides customer delivery information for logistics providers to complete the customer delivery process. Repair and service providers are similarly provided with customer data on an as-needed basis.

7.5 Dell as a Subset of the Multi-Enterprise E-business Model

7.5.1 Similarities between Dell and the Multi-Enterprise E-business Model

To some extent, Dell's business model can be viewed as a subset of the multi-enterprise e-business model. If we try to map the various elements of the Dell model (as shown in Figure 7.3) to the actors in a multi-enterprise e-business framework (section 5.2), we can generate the mapping shown in Table 7.2.

Multi-enterprise e-business actors	Corresponding role in Dell's model
External Customers	Dell's customers
Suppliers	Component suppliers, Sub-system suppliers
E-brokerage	Dell Computer Corporation
Service Providers	Logistics suppliers, Repair/Service providers

Table 7.2: Mapping between actors in the multi-enterprise e-business framework and Dell Computer Corporation's business model

The customer mapping is straightforward. Dell uses Web and Internet technologies to solicit customer orders, and provide on-line feedback and tracking services. It maintains a catalog of its offerings and also allows custom configurations. Dell's component suppliers and sub-system suppliers form its supplier base. Key characteristics of multi-enterprise e-business in its relationship with its suppliers include real-time information exchange via web technologies, and real-time capacity and capability analysis due to integrated supply chains, as identified in section 7.3. Dell Computer Corporation itself plays a role similar to a multi-enterprise e-business e-broker. It is involved with taking customer requirements, evaluating their feasibility in terms of configuration, partitioning the requirements, communicating them to suppliers in real-time, getting a delivery date, communicating it to the customer, providing order tracking services, and coordinating support services (logistics, delivery) to ensure smooth customer delivery. The logistics suppliers and repair/service providers are external services that map to the service provider actor category. Dell, as the e-broker, coordinates the transfer of information to these service providers.

7.5.2 Differences between Dell and the Multi-Enterprise E-business Model

Although Dell exhibits many of the characteristics of a multi-enterprise e-business model, its business is based on a static base of suppliers and service providers. Component and sub-system suppliers are few in number and have long-term commitments, in some cases exclusive commitments, to Dell. This static nature of its structure allows it to forge deep links and integrated supply chains with a small but stable number of suppliers and service providers.

In a sense Dell's model is an example of a closed model, in which it is not easy to integrate new suppliers on-the-fly. The concept of dynamically creating alliances on an as-needed basis does not exist. Supply chains are static, not dynamically created.

One of the primary elements of the multi-enterprise e-business model is the ability to create appropriate coalitions dynamically in order to most effectively leverage competencies and economies of scale. This aspect is missing from the Dell model. It can be argued that given the nature of Dell's business, it is not practical to have a true multi-enterprise e-business model. However, this is true only up to a point. Given the high quality and number of component manufacturers, commodity subsystem manufacturers, technology standards, and certification agencies, we contend that Dell's business model can be extended to leverage some of the key dynamic characteristics of the multi-enterprise e-business model. We will look into this in the following section.

7.6 Multi-enterprise e-business extensions to the Dell model

In order to analyze the impact of incorporating some of the missing elements of the multi-enterprise e-business model, we will analyze two possible scenarios and study their advantages and disadvantages.

7.6.1 Extending the supplier base

In order to extend its supplier base from the current static model, Dell would have to adopt a more flexible model. We will first discuss the advantages and disadvantages of moving to such a model. We will then develop the architecture of such a model.

The primary advantage of moving to a broader supplier base is the ability to leverage the right competencies and economies of scale at any given time. It would also allow Dell to develop a more competitive environment amongst its supplier base, leading to greater cost advantages. It would also reduce Dell's dependence on a small number of static suppliers in the long run. One of the disadvantages of moving to such a model is the associated overhead of managing quality from multiple suppliers. However, the prevalence of standards and certification agencies alleviates this problem to some extent. The greatest advantage can be seen in commodity components and sub-systems.

There are a number of additional architectural components that would need to be integrated into Dell's current model in order to be able to dynamically extend the supplier base. These include a "supplier manager" to certify and integrate suppliers on-the-fly, the ability to dynamically link supply chains with external suppliers or e-brokers, the ability to select the right suppliers based on a real-time analysis of capabilities, the ability to track supplier performance, and the ability to forge and manage supplier contracts and commitments. Figure 7.4 shows an extended version of Dell's current model that allows the integration of external suppliers and service providers.

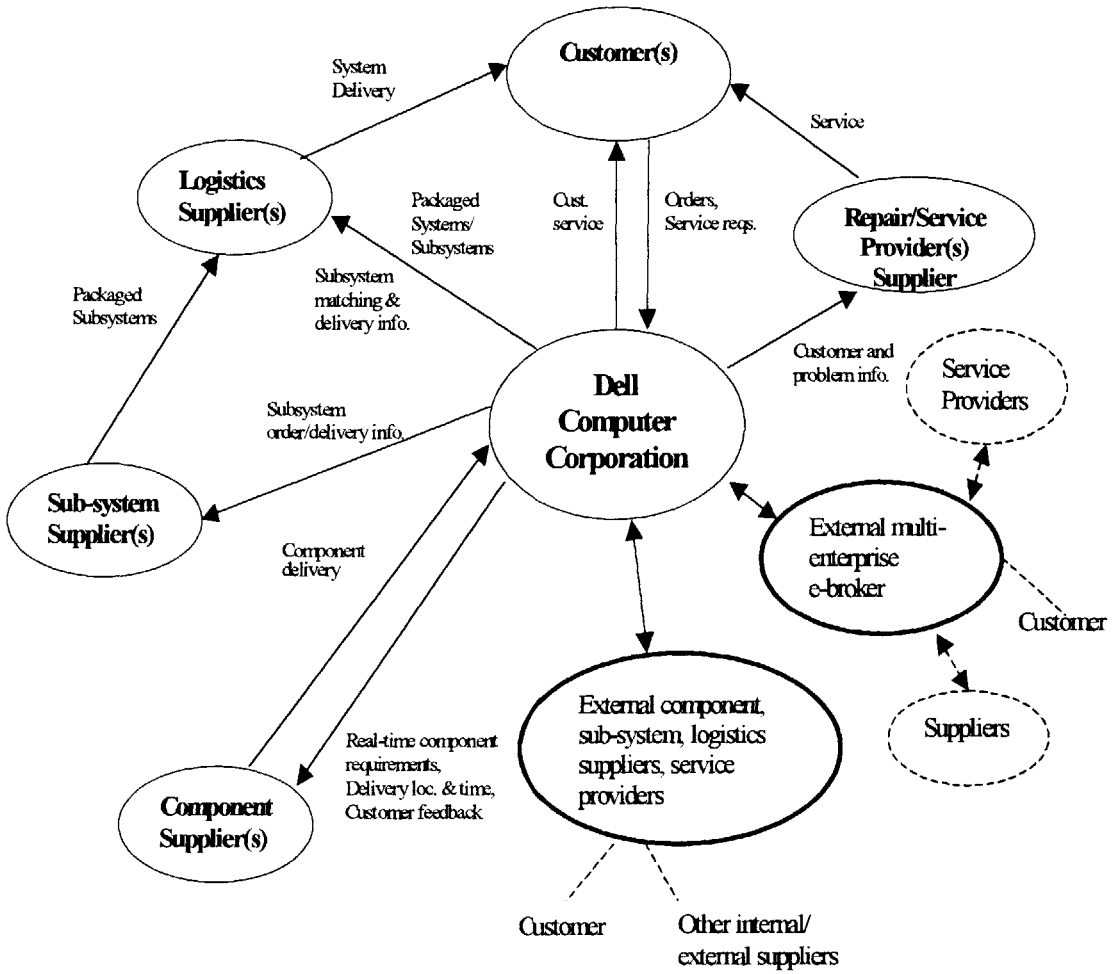


Figure 7.4: Extension to include external suppliers

The bold ovals in Figure 7.4 represent external resources that can be dynamically integrated on an as-needed basis. These resources could be independent suppliers or could be other multi-enterprise e-brokers that have their own community of expandable suppliers and service providers. As identified above, a number of additional architectural features (from chapter 5) need to be added to the Dell model to enable the integration and coordination of new resources on the fly.

7.6.2 Becoming a pure e-broker

Another extension to the Dell model is for Dell to become a pure e-broker in a multi-enterprise framework. Currently Dell plays part of the role of an e-broker with a static environment and also acts as the primary supplier to the customer by virtue of being a manufacturer. This extension would make Dell a pure e-broker by shedding its manufacturing role but retaining its brand identity. Dell enjoys a high degree of brand

recognition, which could be used to brand products delivered by this multi-enterprise e-business.

One of the key advantages is that Dell can expand its supplier base, as in the previous example, and also shed its fixed assets related to manufacturing. It can still maintain its design and marketing competencies and transition to a coordinator of suppliers and service providers for manufacturing and logistics. This transition involves a significant shift in Dell's current model. However, it increases Dell's agility in the long run by turning it into a pure design house with a recognized brand name. It can leverage external manufacturing capacity on an as-needed basis. Figure 7.5 shows this model with Dell as the e-broker.

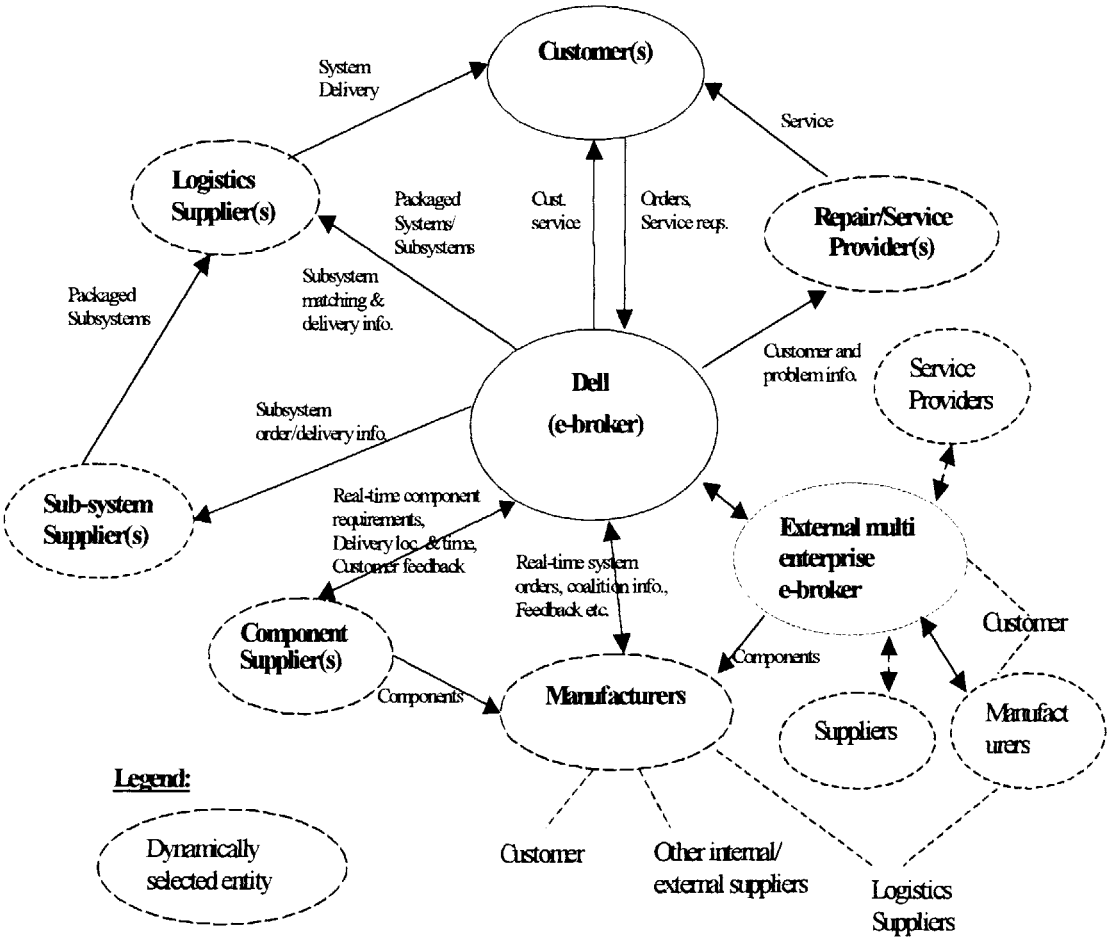


Figure 7.5: Extension- Dell as a pure e-broker

Figure 7.5 shows Dell as a pure e-broker with dynamically selected manufacturers, component suppliers, logistics suppliers, and service providers. Other e-brokers could also be selected dynamically to provide all or parts of a customer order. Dell dynamically selects component and sub-system suppliers depending on current economies of scale and

required competencies and directs the right parts at the right time to selected manufacturers. Systems and sub-systems are then forwarded to dynamically selected logistics suppliers for consolidation and delivery. Dell brands all products in order to leverage its brand identity.

7.7 Summary

We have analyzed Dell Computer Corporation's current business model and supplier interaction and seen that it does contain some of the key elements of the multi-enterprise e-business model. We identified similarities and differences between the Dell business model and the multi-enterprise e-business model. Based on this we proposed two extensions to the Dell model to move it into the domain of pure multi-enterprise e-business. We also identified the advantages and disadvantages associated with these extensions.

8 Conclusion

8.1 Review

As part of this research effort we have defined the concept of a multi-enterprise e-business framework. We started with an analysis of existing e-business models and the need for exploiting the true potential of the Internet for business-to-business e-business. We identified the need and analyzed the motivation for a new model, which resulted in a definition of multi-enterprise e-business. After identifying the requirements this model, we developed an architecture for such a system. In order to demonstrate the use of this model and architecture, we presented two case studies.

This work touches upon a number of themes including the development of a new business model, technical requirements for such a system, and the extension of current e-business models to leverage these concepts. This work can be extended on a number of fronts, as outlined in the next section.

8.2 Future work

Future research efforts in this area can extend this work in a number of directions. Based on the architecture developed in chapter 5, suitable technologies can be identified for implementing each of the components. Additional operational scenarios can be identified and detailed operational studies can be performed. Detailed cases studies, in addition to the two presented here, can also be developed to demonstrate the implementation and benefits of this model in diverse application areas. This model opens up the possibility of extending current business models, as identified in the Dell Computer Corporation case study.

Developing a prototype implementation of a multi-enterprise framework is a logical extension of this work. It will enable the demonstration of the benefits of this model and uncover any implementation challenges and issues.

The multi-enterprise e-business attributes outlined in Table 2.1 provide further areas of research. For each attribute, the architecture developed in chapter 5 provides the necessary high-level components. Further research is required on identifying the implementation details, issues, and challenges. Work partitioning, based on a chosen set of suppliers in a coalition, provides an interesting area of research. The e-broker needs to have the ability to dynamically allocate work and also re-partition and re-allocate work if supplier conditions change. Such dynamic workflow partitioning would need a robust process. Establishing and maintaining dynamic security models poses a number of challenges. Suitable protocols and models need to be developed in order to maintain the integrity of data in a time-bound coalition, and provide a secure environment for exchanging data. The problem could be compounded by the fact that the same supplier might be a part of two different coalitions that need to maintain information privacy with respect to each other. Also, dynamically creating and dissolving partnerships requires

substantial administrative overhead on part of the e-broker. Further work needs to be done on the kinds of agreements are that required, and how they can be implemented and enforced in a changing environment. The need for real-time information access and status monitoring is paramount in a multi-enterprise framework. The evaluation of new technologies to aid in collaboration between partners in order to share information in real-time, is another interesting area of further research. Context mediation in this dynamic and flexible environment is extremely critical. We have mentioned the use of standards like RosettaNet as part of this work. Further work needs to be done in evaluating new and evolving web-based standards to see how they can be incorporated into this model.

8.3 Summary

We have reviewed the key findings of this research and identified areas in which this work may be extended in the future. This work can be extended in the business and technical domains to develop new models and implementations of e-business using the multi-enterprise framework..

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